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Memorandum on the rate of growth of Teak.

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CONTENTS.

For the Manual of Indian timbers, now under preparation, it was necessary to bring together all information available regarding the rate of growth of Teak, and it appears advisable to circulate the results at once with the view of eliciting further data in order to complete the account that will be given in the Manual. The following data were brought together with the assistance of Mr. A. Smythies, Assistant Conservator of Forests, Forest School Circle, North-Western Provinces.

2. A brief account of what was known regarding the rate of growth of Teak up to 1873 was given on pages 357-359

of the Forest Flora of North-West and Central India. Since then, further data have been collected; but the chief addition to our information on this subject has been made by the publication of Colonel Beddome's Report of 1878 on the Nilambur Teak Plantations. The data here brought together in no way give a complete account of the rate and mode of growth of Teak, and doubtless much more information is available which has not yet been published. It is a most important subject, which should now be taken up separately in each province where Teak is cultivated on a large scale, and its study is earnestly recommended. The following remarks will most conveniently be grouped under the head of annual rings, girth and height at different ages, cubic contents of individual trees, and the number of trees and cubic contents of growing stock per acre. It will be remembered that the rate of growth of every species varies between wide limits according to climate, soil and numerous other circumstances which affect the development of trees.

3. *Annual rings.*—It is now established beyond doubt that the concentric rings which are so marked in the wood of Teak correspond each to one year's growth. The following statement exhibits the rings counted on sections of trees grown in the Nilambur Plantations, which were cut in 1877. The sections were taken from the base of the stem, and, with a few exceptions, the number of rings agrees with the age of the tree. The average diameter is the mean of three diameters. The statement shows the gradual increase of the heartwood as the tree grows older, and it also exhibits the number of rings on one inch of average radius in the wood of trees of different ages. But it must be borne in mind that these sections do not rep resent the average of each year's plantation, but were selected from among the dominant trees. They, therefore, exhibit a more rapid rate of growth than average specimens would do :—

Year of plantation.	Number of rings counted.	Average diameter of section (wood only.)	Average diameter of heart-wood.	Rings per inch of average radius.
		In inches.	In inches.	
1844 ...	33	20·8	19·3	3·17
1845 ...	31	21·1	18·7	2·95
1846 ...	31	20·	17·7	3·10
1847 ...	30	23·8	21·5	2·52
1848 ...	28	16·7	15·4	3·34
1849 ..	28	18·1	16·2	3·09
1850 ...	27	14·	12·5	3·85
1851 ...	25	15·2	13·4	3·28
1852 ...	32*	15·2	13·5	Omitted.
1853 ...	24	15·1	12·	3·17
1854 ...	24	17·3	15·2	2·77
1855 ...	23	12·4	10·5	3·71
1856 ...	21	15·2	12·6	2·76
1857 ...	20	12·2	10·6	3·27
1858 ...	19	14·	11·3	2·71
1859 ...	18	14·	10·6	2·57
1860 ...	17	12·9	10·4	2·63
1861 ...	16	13·1	10·5	2·44
1862 ...	15	11·7	9·	2·56
1863 ...	14	13·6	10·4	2·06
1864 ...	13	12·5	9·4	2·08
1865 ...	12	9·4	6·9	2·55
1866 ...	11	10·4	7 3	2·11
1867 ...	10	11·8	8·3	1·69
1868 ...	9	10·5	7·6	1·71
1869 ...	8	7·4	4·8	2·16
1870 ...	7	7·4	4·5	1·89
1871 ...	7	7·7	4·3	1·81
1872 ...	5	6·5	2·6	1·53
				Average 2·62 rings per inch of average radius.

4. The sections ranged in age from 5 to 33 years. Dividing them into three groups, two of 10 years each, and the third of nine years, we obtain the following as the mean diameter in inches of these three groups :—

		Inches.
Mean diameter of trees	5—14 years old ...	9·72
	15—24 „ ...	13·79
	25—33 „ ...	18·71

* There is evidently a mistake here. The tree which yielded this section must have been an older tree standing in the plantation of 1852.

A section sent from the Thinganneenoung Plantation in Burma, cut from a tree 21 years old, planted in 1856, gave 21 rings on a mean diameter of 16·3″, the heartwood of which occupied 14·5″. This section showed 2·57 rings per inch of average radius.

5. From other plantations also, sections of Teak trees of known age were sent for the Paris Exhibition, but apparently they were not in all cases cut from the base of the stem; they are, however, instructive as showing the rate of growth and the number of rings on one inch of mean radius.

Year of plantation.	Number of rings counted.	Average diameter of section in inches.		Rings per inch of average radius.
		Wood.	Heartwood.	
South Kanara (Parappa Plantation).				
Not known ...	10	9·	4·9	2·22
" ...	5	5·5	2·5	1·81
North Kanara (Kalanadi Valley).				
Sulageri, 18 years old	18	8·	6·	4·5
	17	8·8	7·5	3·9
	17	9·	7·	3·7
Murdi, 12 years old	8	7·5	Heartwood not distinct.	2·1
	11	6·		3·7
	11	5·7		3·8
Kadra, 10 years old	8	6·5	...	2·5
	8	7·5	5·	2·1
	7	7·	4·	2·
Bengal (Bamunpokri).				
1868	8	6·5	2·5	2·5
1871	6	6·	1·	2·
1872	4	5·	1·	1·6
Andamans (Port Blair).				
1873*	6	10·1	6.	1·2

6. It will be noticed that, as far as the data go, which are furnished by the sections received, Thinganneenoung and Bamunpokri exhibit an increase of diameter similar to that of Nilambur; while in the samples from North Kanara the annual rings are much narrower, and the specimen from Port Blair showed an extremely rapid rate of growth.

Girth and height at different ages.—The following measurements illustrate the rate of growth of Teak in plantations in

*The tree was probably older.

different provinces as nearly as possible from 5 to 5 years. The Nilambur Plantation again furnishes the largest amount of information :—

Age.	Mean girth at breast high.	Total height of tree.
Nilambur Plantation.—Alluvial soil.		
3—7 years ...	12 inches ...	29 feet.
8—12 „ ...	17 „ ...	63 „
13—17 „ ...	23 „ ...	68 „
18—22 „ ...	25 „ ...	71 „
23—27 „ ...	27 „ ...	77 „
29 „ ...	34 „ ...	87 „
30 „ ...	35 „ ...	85 „
31 „ ...	32 „ ...	75 „
32 „ ...	34 „ ...	92 „
33 „ ...	37 „ ...	95 „
Nilambur Plantation.—Gneiss and laterite.		
7 years ...	13 inches ...	30 feet.
16 „ ...	14 „ ...	50 „
20 „ ...	21 „ ...	50 „
24—26 „ ...	22 „ ...	52 „
30 „ ...	24 „ ...	50 „

These figures are taken from that portion of Colonel Beddome's report (paragraphs 11— 44) which contains his notes on each year's plantation, and the data recorded are stated to be average figures.

8. In another part of his report (paragraph 81), however, he gives data which would seem to show that the average size of the trees in the older plantations (all on alluvial soil) is considerably greater. He there states the dimensions of the largest, smallest and medium-sized trees, four plantations, the results being as follows :—

Age.	Mean girth (probably breast high.)			Length of bole.		
	Largest.	Medium.	Smallest.	Largest.	Medium.	Smallest.
	Inches.	Inches.	Inches.	Feet.	Feet.	Feet.
30 years ...	67	47	29	79	65	50
31 „ ...	69	49	30	80	65	50
32 „ ...	63	46	30	83	67	50
33 „ ...	68	56	43	86	68	50

The first three lines show the average of 6 trees in each case, and the last line the average of 8 trees each. It is distinctly stated that the length is that of the bole, and not of the entire tree.

The plantations made on gneiss and laterite show a much slower rate of growth than those on alluvial soil ; the difference being considerable in height, and much less in girth.

9. Up to 10 years of age, the growth in length of teak on alluvial soil at Nilambur is at the rate of about 6 feet a year, and later on it is at the rate of only about 1 foot a year. On page 358 of the Forest Flora of North-West and Central India it is stated " that it is probable that, as a rule, Teak attains half its length with a girth of 2—3 feet." This assumption is borne out by the present figures. The trees grown upon alluvial soil in girth between 25 and 34 inches are from 77 to 87 feet high ; and from all that is known regarding the growth of Teak in similar localities, it is probable that unless damaged by storms, disease, insects, or other causes, they will attain a height of 150 feet in soil of this description, and in the climate of Nilambur.

10. From Burma we have the following data. The figures from Pegu represent averages of plantations in the Rangoon, Toungoo and Tharawaddee districts, brought together on page 358 of the Forest Flora of North-West and Central India :—

	Age, in years.	Mean girth, breast high, in inches.	Total height of tree, in feet.
Pegu	4	5—9	15—27
	10	15	40—45
	15	23	...
Thinganneenoung... ...	21	27	50—60
Garden—Moulmein	22	40	...

The fourth line is the average of 150 trees in the Thinganneenoung Plantation in the Attaran district of Tenasserim, given in paragraph 146 of the report for 1876-77 of the Tenasserim forests. Major Seaton gives the average height at 30—40 feet, but this probably means the height to the first

branch. The maximum girth was 55½ inches. The average rate of growth of the present plantations in Burma is somewhat less rapid than that of the alluvial portion of Nilambur. The last line gives the average of 15 trees measured in 1856 in a private garden at Moulmein. An instance of extremely rapid growth was the tree already mentioned, a section of which was sent from Port Blair for the Paris Exhibition, probably 6 years' old (said to have been planted in 1873, but 6 rings were counted), with a girth of 36 inches and a height of 44 feet.

11. For the Lakvalli Plantation in Mysore, the following data are given in Captain Van Someren's report for 1875-76. Age 13—15 years, mean girth 14 inches, height 32 feet. This is a remarkably slow rate of growth, considering that the soil is good, and the climate moist, though of course not so forcing as the climate of Nilambur.

12. The plantations in the Central Provinces and Berar have given the following :—

Plantation.	Age, in years.	Mean girth, breast high, in inches.	Total height of tree, in feet.
Machna, Central Provinces ...	6	7	15—22
Pili, Berar	6	4	10
Sakata, Central Provinces ...	7	11	20—25
Pili, Berar	8	8	20
Sonawani, Central Provinces ...	9	12	30—40
Machna, Central Provinces ...	8—10	9	17—30

Compared with Malabar and Burma, the rate of growth is slow, as may be expected in a dry climate and near the northern limit of the tree.

13. Outside the range of the natural growth of Teak, the following data, regarding its rate of growth, are available :—

Plantation.	Age, in years.	Mean girth, breast high, in inches.	Total height of tree, in feet.
Bamunpokri (Sikkim) ...	5	5·5	12—15
Kulsi (Assam)	5	11	29
Makum „ ...	4	9	18
„ „	5	11	27
„ „	7	16	31

The growth at that early age is fairly good; but it does not follow from these figures that Teak in Assam and Sikkim will attain a great age, and produce good timber.

14. The following instances of older trees of known age in Assam and Bengal are on record :—

Locality.	Number of trees measured.	Age, in years.	Mean girth, in inches.
Gauhati, banks of the Brahmaputra	15	37	85
Royal Botanical Gardens, Calcutta	19	6	16
Ditto ditto ...	8	70	79
Garden at Mohesh, Serampore...	27	50	52

The trees at Gauhati were on an average 30—50 feet high.

The trees in the Botanical Garden, Calcutta, were measured in January 1856. The older trees have since been blown down by the cyclones of 1864 and 1867.

On the banks of the Hooghly at Mohesh, below Serampore, stands a grove of Teak trees planted in 1828. Their mean girth, breast high, taken by measuring 27 average-sized trees, was 52 inches. The trees were measured in January 1878, and were therefore 50 years old. They are from 40—50 feet high.

15. In paragraphs 177 and 183 of Dr. Schlich's report for 1872-73, the dimensions of a large number of Teak trees at different stations of Lower Bengal are given; but unfortunately no trustworthy information regarding their age is available.

16. *Cubic contents of trees at different ages.*—In paragraph 4 of Colonel Beddome's report a statement is given exhibiting the dimensions of the trees, sections of which were sent to the Paris Exhibition. As already stated, these trees were selected as samples of the dominant trees, *viz.*, of those which will eventually be selected to remain on the ground as the ultimate crop; but, with few exceptions, they were not selected from among the largest individuals which had much outrun their neighbours. Arranging them in groups from 10 to 10 years, the following results are obtained :—

Age.	Height of tree, in feet.	Girth at base, in inches.	Length of bole, in feet.	Mean cubic contents, in cubic feet.
4—13 years ...	48—75	21—60	32—56	10·6
14—23 „ ...	65—110	51—69	40—70	23·8
24—33 „ ...	70—110	60—105	41—72	51·3

This gives us the cubic contents at different ages as follows :—

Mean age.	Cubic contents, in cubic feet.	Periodical annual increment, in cubic feet.
9	10·6	1·1 to 9 years.
19	23.8	1·3 from 9 to 19 years.
29	51·3	2·8 from 19 to 29 years.

The annual increment increases steadily to the age of 30 years, and probably continues increasing for a considerable time beyond it.

17. *Number of trees and cubic contents of growing stock per acre.*—Regarding the number of trees and the growing stock per acre at different ages, we depend almost entirely upon Nilambur for our data. Sample areas of half an acre each were selected in each of seven plantations; each tree was measured, the cubic contents determined, and the following is the result. It is not expressly stated, but it is probable that these sample areas were all selected on alluvial soil :—*

*The length of stem to the top of sale measurement, where the head begins, of every tree in the plantations of 1844 to 1848, both inclusive, was measured by sending up a climber with a tape. In the plantations of 1858 and 1868 a large number of felled saplings were available, of which the average was taken.

The mean quarter girth was determined in the following manner:—Ten saplings were measured breast high, and in the middle of the stem at half its length, and this gave $\frac{3}{4}$ as the reducing factor. Those trees 30 inches in girth breast high were found to have a girth of 25 inches in the middle of the bole.

Name and year of plantation.	Age of plantation, in years.	Number of trees per acre.	Average length of bole, in feet.	Mean quarter girth of trees, in inches.	Cubical contents in cubic feet.		Average annual increment, in cubic feet.	
					Per tree.	Per acre.	Per tree.	Per acre.
Iravelly Kava...1844	33	120	59	9·7	41	4,879	1·2	148
Elanjerry ...1845	32	158	61	7·9	30	4,742	·9	148
Elanjerry ...1846	31	156	60	7·4	27	4,204	·9	136
Moolathamanoo 1847	30	140	62	7·5	27	3,713	·9	124
Moolathamanoo 1848	29	156	60	6·8	21	3,243	·7	112
Elanjerry ...1858	19	270	45	5·0	8	2,203	·4	116
Wallashary ...1868	9	750	40	3·4	3	2,491	·4	277

18. Colonel Beddome estimates that on alluvial soil, the Teak at Nilambur will reach maturity at from 60 to 80 years; that fellings will be spread in each plantation over 50 years; and that at the time of cutting (say at 85 years of age) the mean quarter girth will be 2 feet, the length of bole will be 70 feet, and the mean cubic contents of each tree 280 cubic feet. He also estimates that, at that age, there will only be 60 trees to the acre, making the cubic contents per acre 16,800 cubic feet.

No safe speculations can be formed regarding the future of a pure Teak forest like that of Nilambur. In its natural state, Teak does not grow alone, but is associated with Bamboos and a variety of other trees; and it is impossible to foresee the risk of damage by storms, insects, disease, or other causes to which pure Teak forests may be exposed. It may be doubted whether, even on the best alluvial soil, the average mean girth of trees 85 years of age will be as much as 8 feet. On the other hand, it is not impossible that the bole will be longer than 70 feet, and it is probable that it will be advantageous to allow more than 60 trees per acre. On page 155 of the Attaran Report of 1860, a plot in the Tsintsway forests (Yoonzaleen) is described, measuring 3,833 square feet, and stocked with 8 Teak

trees with clear stems to the first branch of 50 feet, the girth between 4′ 6″ and 6′ 5″; this would give 91 trees to the acre. Full stocked forests of Oak and Beech in Europe 130—180 years old under favourable conditions contain 120—140 trees per acre, with a cubic content (including tops and branches) of about 11,000 cubic feet. A forest of Silver Fir in the Jura, 180 years old, was found to contain 94 trees per acre, with a cubic content of 16,000 feet.

19. The total area now stocked at Nilambur is 3,436 acres, of which 1,787 are stocked with a full crop on alluvial soil, the rest not being expected to yield a full crop. In his estimate of the future value of the plantations, Colonel Beddome only assumes 6,000 cubic feet as the full crop expected on alluvial soil.

In natural forests, where Teak is associated with Bamboos and other trees, the number of the first and second class Teak trees (above 4′ 6″ in girth) rarely attains 10 trees per acre over large areas. The following are instances of forests exceptionally well-stocked with Teak :—

Date of survey.	Forest.	Area.	Number per acre.		Total.
			Class.		
			Girth above 6 feet.	Girth 4½ to 6 feet.	
1876 ...	Bimaram (Central Provinces.) ...	50 acres ...	4	4·3	8·3
1870-71 ...	Pegu (Prome District) ...	17 square miles	3·6	3·0	6 6

Sketch of the Flora of Rajputana.

By George King, M.B., F.L.S.,
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As might be expected from its geographical position and limited rainfall, the flora of Rajputana is not a rich one. The number of indigenous species is but small, and few of these are attractive in appearance. The province is divided by the Arvali range of hills into two unequal parts—the part to the eastward of the range lying in the basin of the Chambal, and that to the westward in the basin of the Indus. This division is, to a great extent, coincident with certain features in the physical configuration, meteorology and vegetation of the province; and these two portions may, therefore, be conveniently treated of separately. The vegetation of the dividing range itself, and of the outlying mountain mass of Aboo, so much more resembles that of the eastern than of the western tract, that it may be treated along with the former.

Eastern Rajputana.—The country to the east of the Arvali is (with the exception of the Jaipur State) more or less hilly, and has a climate and a flora resembling those of Central India and the North-Western Provinces. Where not actually hilly, the surface is, to a considerable extent, undulating. Cultivation is, on the whole, scanty, and is chiefly confined to the lower and flatter lands, while the higher parts remain to a large extent covered with their original vegetation, and on them may be found in abundance plants which, in the more completely cultivated provinces of North-Western India, are confined to the comparatively small tracts of waste and unreclaimed land.

As is the case in other parts of India with a similar vegetation, the majority of the trees and shrubs come into flower during the hot season, while the herbaceous plants blossom chiefly during the rains. Many of the latter are, moreover, annuals which wither and die as the cold season approaches. The cold season corresponds to the winter of temperate countries, and during the whole of it the aspect of the uncultivated parts of the country is brown and barren. The flowering of the shrubs and trees during the hot weather does little towards increasing the beauty of the scenery. On the contrary, it, if

anything, intensifies the feeling of barrenness and aridity. With the first fall of rain, myriads of seeds that had lain dormant in the parched soil spring into life, and in the course of an incredibly short time the whole of the country, even to the tops of the barest hills, is clad in a carpet of delicate green, while the pleasant sound of running water can actually be heard in the valleys. The largest tree of this part of Rajputana is the Semul (*Bombax malabaricum*), which on the Arvalis and Aboo attains a considerable size. The finely buttressed grey trunk, spreading arms and gaudy red flowers of this species make it a striking object in the landscape wherever it occurs. Ranking after the Semul in size are *Prosopis spicigera*, *Sterculia urens*, *Semecarpus Anacardium*, the two Acacias (*leucophlæa* and *Catechu*), *Anogeissus latifolia* and *pendula*, *Dichrostachys cinerea*, *Cordia Rothii*, *C. Myxa*, and *Phyllanthus Emblica*. These yield both fuel and building timber in parts of the region where neither is over-abundant. *Erythrina suberosa*, with its ungainly trunk and branches but handsome scarlet flowers, and the pretty geranium tree of the Anglo-Indian (*Bauhinia purpurea*), are not uncommon. *Gmelina arborea*, a tree which yields an excellent timber, and which occurs over almost the whole of India and Burma, is found sparingly in the Arvalis. The gum-yielding salai tree (*Boswellia thurifera*), so abundant in the territory to the eastward of the tract, is not uncommon in Meywar and the Arvalis. The dâk or pallás (*Butea frondosa*), which in various parts of Central India covers immense areas to the exclusion of pretty nearly every other tree, is far from abundant in any part of the region. Two Terminalias (*tomentosa* and *Arjuna*), both valuable as timber trees, occur sparingly on the eastern frontier of the tract, but are rare elsewhere. *Schrebera swietenioides*, a little-known and rather rare tree, has been found by Dr. Brandis in Meywar.

Climbing plants are not numerous, the most notable being two species of Cocculus (*villosus* and *Leœba*), *Cissampelos Pareira*, *Celastrus paniculatus*, two vines (*Vitis carnosa* and *Vitis latifolia*), and *Mimosa rubicaulis*.

The shrubby vegetation, which in every part of the region is so much more prominent than the arboreal, consists largely

of capers, jujubes, tamarisks, and *Grewias*. Of the capers by far the commonest is *Capparis aphylla*, a prickly leafless shrub with a handsome plum-like fruit, which flourishes over all the driest parts of North-Western India, and extends to Arabia, Nubia, and Egypt; *Capparis spinosa* (which yields the eatable caper) is much less frequent; *Capparis horrida*, a scrambling plant which often climbs on trees, is not uncommon; while a fourth species *Capparis sepiaria* (indigenous in the south of India), is here and there cultivated as a hedge plant. The small jujube (*Zizyphus nummularia*) is very abundant, and, covering, as it often does, large tracts of country, has great value as a fodder plant: it is also much used for hedges. *Zizyphus xylopyra* is a less abundant species, which sometimes, in protected spots, attains to the dignity of a small tree and yields a useful wood, while its bark is used in tanning. In every water-course tamarisks of several species abound. One of these (*Tamarix gallica*) is a cosmopolitan plant, which is found in suitable localities all over India and Ceylon, in China, Japan, and Siberia; specimens of it have been gathered in Yarkand, in Thibet, at 11,000 feet above the sea, and it is common in many parts of Northern Africa and Southern Europe. *Tamarix dioica*, an exclusively Indian species, is also abundant. Of the Grewias, *Grewia populifolia*, *Grewia pilosa*, *Grewia villosa*, and *Grewia salvifolia* are the common species. These all yield tough wood, which, however, is rarely large enough to be of much use; and the fruits of all four are more or less eatable. In addition to these, the most notable shrubs are *Helicteres Isora*, the curious spirally curled seed-vessels of which have a fanciful value as a remedy in dysentery: *Celastrus spinosus* and *Celastrus senegalensis*, *Buchanania latifolia*, *Cassia auriculata*, *Woodfordia floribunda* (the scarlet flowers of which are used as a dye), *Casearia tomentosa*, *Diospyros montana*, *Holarrhena antidysenterica* (named from its reputed value as a cure for dysentery), *Calotropis procera*, *Vitex Negundo* (esteemed as a remedy for rheumatism), and *Clerodendron phlomoides*. Two cactus-like fleshy *Euphorbias* (*Euphorbia Royleana* and *Euphorbia neriifolia*) occur in the hills, but are much less abundant than in the tract to the west of the Arvalis.

Bamboos are represented by a single species (*Dendrocalamus strictus*), which attains large dimensions only on Aboo and the higher parts of the Arvalis.

The herbaceous vegetation consists of *Leguminosæ* of the genera *Alysicarpus*, *Desmodium*, *Crotalaria*, *Cassia*, &c., of various widely distributed species of *Compositæ* and *Rubiaceæ*; *Boraginaceæ* being also rather numerous, and *Scrophulariaceæ* less so. During the rains a few *Convolvulaceæ* appear, and grasses and sedges are abundant.

Owing to its heavy rainfall, Aboo is, as regards vegetation, by far the richest spot in Rajputana. On the higher parts of the mountain, humid types appear which are unknown on the plains below. Most noteworthy of these is an epiphytal orchid (a species of *Aerides*) which clings to the mango trees, and in the rains produces fine racemes of delicate pink flowers. The occurrence of a charming white wild rose and of a stinging nettle (*Girardinia heterophylla*) also at once reminds the visitor to Aboo that he has left the arid region below, and recalls to his mind the semi-temperate vegetation of the Himalayas and Nilgiris. Magnificent trees of *Michelia Champaca* are found, especially beside the temples, and weeping willows adorn the margin of the lake near the station; but the latter two species have both doubtless been planted. A yellow jasmine (*Jasminum revolutum*) abounds on Goroo-Sikhur, the highest peak of the mountain; but this is also doubtfully indigenous. *Cratæva religiosa*, with its creamy yellow flowers and delicately-tinted stamens, is common on the middle and lower slopes of the hill; while *Carissa Carandas* is so abundant that during part of the hot season its pretty white flowers scent the air for miles round the station with their delicious fragrance. The prevailing tree on the slopes of Aboo is the mango. It is doubtfully indigenous and was probably originally introduced by the numerous pilgrims who have for ages frequented the sacred shrines for which the mountain is famous. Now, however, it is thoroughly naturalised, and is the commonest of the larger trees. *Pongamia glabra* is found in several of the lower valleys of Aboo (wherever it occurs on the plains below it has usually been planted) and *Sterculia colorata* is not uncommon. Shrubby and

herbaceous *Acanthaceæ* of several species abound. Very common also is *Mallotus philippinensis*, the powder covering the capsules of which forms at once a valuable dye-stuff and an efficient vermifuge. On the lower slopes of the mountain, and in the dense belt of jungle which surrounds its base, are found most of the species which are characteristic of the plains. Many of the latter (for example, *Salvadora persica*) ascend to the very highest peaks of the mountain, and thus intermix with the more temperate forms which are confined to the latter.

Of introduced Indian plants which are found usually in gardens or near villages over the whole of the eastern tract, the most prominent are the peepul (*Ficus religiosa*), the banyan (*Ficus bengalensis*), the gular (*Ficus glomerata*), the ungeer (*Ficus virgata*), the mulberry (*Morus alba*), the tamarind (*Tamarindus indica*), the mango (*Mangifera indica*), the nim (*Melia Azadirachta*), the bábul (*Acacia arabica*), the ber (*Zizyphus jujuba*), the siris (*Acacia Lebbek*), the jamun (*Eugenia Jambolana*), the mehndi (*Lawsonia alba*), the pomegranate (*Punica Granatum*), and the peach (*Amygdalus persica*). *Mimusops indica* and *Elengi*, *Ailanthus excelsa*, and *Flacourtia Ramontchi* are also occasionally met with. The bábul is quite naturalised in spots where the winter cold is not too intense, and where the sub-soil retains a little moisture: its timber and bark are both highly prized. Among fruit trees cultivated in gardens, two American species are very common; these are the custard apple (*Anona squamosa*), and the guava (*Psidium Guava*). *Argemone mexicana*, *Parkinsonia aculeata*, *Opuntia Dillenii*, and *Acacia Farnesiana* (also introductions from America), are frequently met with. *Nerium odorum*, a shrub closely allied to, if not identical with, the oleander of Southern Europe, is also common in gardens.

Western Rajputana.—To the westward of the Arvalis the country is much flatter and drier, and as the Sind and Punjab frontiers are approached, it passes into actual desert. It is, however, by no means destitute of hills, for numerous low ridges of a red sandstone rise here and there, and in other parts there are undulating areas of hardened sand. The rest of the

country is for the most part a plain of loose sand, which, everywhere more or less saline, becomes increasingly so towards the south-west, where the Loni loses itself in the Runn of Kutch. Except that they support a few of the fleshy *Euphorbias* already mentioned many of the hilly ridges are utterly barren. The little rain that falls on these bare rocks is at once carried off in rapid torrents which are often lost in the sand at a short distance from their bases. The few torrents which do succeed in carrying their water to any distance unite to form the Loni, the one river of this part of the country. But although water can be had by digging at certain parts of its bed at almost any season of the year, and stagnant pools may here and there be found at all times, it is only during the brief and scanty rainy season that anything like a continued current can be seen in any part of the Loni. The rainfall, which over the whole area is scanty and uncertain, gradually diminishes as the Sind and Punjab frontiers are approached. Erinpura, a station near the base of the Arvalis, has a rainfall of about 12 inches in the year; whereas Western Marwar, Jesulmir, and Bikanir have probably less than a third of that amount.

It must not be supposed that the Arvali range forms a rigid boundary separating two distinct floras; on the contrary, the majority of the plants already mentioned as characteristic of the eastern tracts are found on the west of the range. Near the base of the Arvalis, the soil is good and supports a belt of what would, for Western Rajputana, be a comparatively luxuriant vegetation, were it not ruthlessly preyed on by the inhabitants for fuel and timber for themselves and fodder for their cattle and camels. In passing westward from the Arvalis, such of the species already mentioned as are unable to withstand the increasing dryness of the climate, and the saltness of the soil, are represented in gradually diminishing numbers by stunted, half-starved specimens, and the majority of them finally disappear altogether. On the other hand, a few species of a thoroughly desert type gradually appear, and these latter increase in proportion to the former, until on the western frontier of the region they form almost the entire vegetation. These desert plants are outliers of the Arabian and North African

flora, and are common to all low-level Asiatic deserts, while some of them penetrate even to the comparatively high arid tracts of Central Asia. Next to the floral poverty of this tract, the most notable fact that strikes the observer is the tendency of plants, which in moister regions are herbaceous, here to become tough and shrubby, and of the whole vegetation to develop epidermal armature in the shape of hairs and thorns. The common weed (*Solanum Jacquinii*) which in the Gangetic plain is moderately covered with stiff bristles, here presents the appearance of a vegetable hedgehog. The spines of the bábul are about twice as long and as thick as they are in Malwa, while the small ber bushes, everywhere formidable, are here little more than mere bundles of spines.

The largest trees in Marwar are those that have been planted in gardens and near tanks or wells. Hardly one of any indigenous species is ever found exceeding ten or twelve feet in height. The commonest of these latter are *Prosopis spicigera Salvadora persica, Cordia Rothii, Acacia leucophlœa*, with *Acacia arabica* in the kind of spots already indicated, and *Sterculia urens* on the less barren hills. *Anogeissus pendula* and *Dichrostachys cinerea* occur but sparingly, and hardly ever exceed the dimensions of under-shrubs. Towards the Sind desert, the only tree to be found wild is said to be *Acacia rupestris*, a form almost totally absent from the eastern tract.

By far the handsomest shrub indigenous to this part of Rajputana is *Tecoma undulata*, which has the double merit of bearing large orange-coloured bell-shaped blossoms, and of bearing them simultaneously with its handsome shining leaves. This plant is so indifferent to climatic conditions that, although naturally found on some of the drier ridges of Marwar, it thrives excellently in the Botanical Garden in the steamy climate of Calcutta—a peculiarity which it shares with *Dichrostachys cinerea* and *Acacia leucophlœa*. Next to *Tecoma undulata*, the finest indigenous shrub is *Acacia Jacquemonti*, the polished stems and thorns and sweet-scented yellow flowers of which make it an object of much beauty and interest. In addition to these, the shrubby vegetation is composed of the following species already mentioned as occurring more abundantly in the eastern tract :—

Capparis aphylla and *spinosa*; *Helicteres Isora*; *Grewia populifolia, pilosa, villosa*, and *salvifolia*; the two *Zizyphi* (*nammularia* and *xylopyra*); *Cassia auriculata*; *Clerodendron phlomoides*, and *Vitex Negundo*. The tamarisks already mentioned are found abundantly in the salt-impregnated bed of the Loni, and two other species of the same family (*Tamarix articulata* and *Myricaria germanica*) also begin to be found. Both these are common in Afghanistan and in Western Asia generally; while the second of the two extends also to high altitudes both in the Himalayas and in some of the mountain ranges of Northern Europe. *Balanites Roxburghii* (a prickly scraggy shrub common in Southern India, Central Provinces, and other dry parts of India) is here pretty common. *Balsamodendron Mukul*, a shrub which yields a gum called *mukul* or *gugal*, and which extends to the dry countries far to the westward of India, begins here to be as abundant as east of the Arvalis it is rare. *Ephedra alte*, a bush common in the west of Asia and north of Africa, is said to have been found in Jesulmir. The pretty little camel-thorn (*Alhagi Maurorum*) which, occurring in the eastern tract and far beyond it in India, is also distributed in Southern Europe and Western Asia, here forms a prominent feature in the vegetation of the sandy tracts. Associated with it are a few other bushes, such as *Calotropis procera* and *Orthanthera viminea* (both of which yield an excellent fibre), and here and there *Periploca aphylla*.

Of the herbaceous vegetation, the prominent species may be indicated as follows: *Peganum Harmala* (a rutaceous plant, which is found in the Deccan and Punjab, and which is distributed to the westward along the Mediterranean coasts as far as the Atlantic) occurs in plenty in many spots, as, for example, near Palli. *Polygala abyssinica* is not unfrequent in places. The most abundant leguminous plants are *Crotalaria Burhia* (much valued for fodder) and *Tephrosia purpurea*. *Compositæ* are represented by one or two *Blumeas*, *Vernonia cinerea*, *Microrhynchus nudicaulis*, and *Berthelotia lanceolata*; here and there *Tricholepis radicans* and *Echinops echinata* are to be seen; and near irrigated spots may be met with *Machlis hemispherica*, *Sphæranthus hirtus*, and *Cyathocline lyrata*.

Not uncommon in gardens as weeds of cultivation are *Saponaria Vaccaria*, *Trianthema crystallina*, *Asphodelus fistulosus*, and *Fumaria parviflora*. Of Acanthaceous plants, the most frequent are *Lepidagathis trinervis* and *Barleria noctiflora*, with here and there two plants of wide distribution in India,—namely, *Justicia procumbens* and *Peristrophe bicalyculata*. *Boragineæ* are numerous in individuals belonging to the genera *Eritrichium* and *Arnebia*; *Trichodesmus indica* and *Tournefortia subulata* are common near Jodhpur. Several *Cleomes*, one or two *Farsetias*, two or three species of *Abutilon* and *Sida* are also common. *Tribulus terrestris*, *Corchorus depressus*, *Verbena officinalis*, *Lippia nodiflora*, *Bergia æstivosa*, *Cressa cretica*, *Convolvulus arvensis*, *Evolvulus pilosus*, *Withania somnifera*, *Solanum xanthocarpum* var. *Jacquinii*, *Salvia brachiata*, *Polygonum Roxburghii*, and *Aristolochia bracteata* are found in spots where there is a little admixture of vegetable mould, and by the margins of tanks and irrigated spots. *Amarantaceæ* are represented by *Achyranthes aspera*, *Alternanthera sessilis*, *Amaranthus lividus*, *Aerua lanata*, and *Pupalia velutina*. Such *Chenopods* as *Anabasis*, *Atriplex* and *Salsola* abound where, as towards the mouth of the Loni, the sand is highly saline. Parasitic on the roots of *Calotropis* is a pretty species of *Orobanche*. The tanks are not destitute of vegetation, for in their water may be found, though sparingly, *Vallisneria spiralis*, *Utricularia stellaris*, *Potamageton pectinatus* and *natans*, while by their margins several species of sedges, and notably *Hymenochæte grossa*, are often abundant. Several species of *Andropogon*, *Anthisteria*, *Cenchrus*, and other wiry grasses are distributed over the whole area; and towards the Sind frontier one of these, known locally as *mart*, constitutes a large proportion of the scanty vegetation. Besides this grass, the vegetation on that frontier consists almost exclusively of the small acacia tree already mentioned (*Acacia rupestris*), of a plant of the rhubarb family with curious hairy seed-vessels known locally as *phog* and botanically as *Calligonum polygonoides*, the woolly-looking plant *Aerua lanata* (locally called *bhin*), *Anabasis multiflora*, and a troublesome bur grass, *Cenchrus biflorus*.

In the sandier parts of this western tract the staff of life is derived from a rain crop of millet, which is sown as soon as a shower in July or August makes it worth while to give a hurried ploughing to the patches of soil which the inhabitants are pleased to call fields. Wheat is a garden crop confined to the small patches which it is possible to irrigate from wells. In the sands of Bikanir, water-melons occur spontaneously in such numbers as to form for some months in the year no small part of the food of the scanty population. The seeds of these and of other cucurbitaceous plants cultivated in gardens are ground, during times of scarcity, into a kind of flour.

From the preceding sketch it may readily be inferred that the country is barren and infertile, and it is difficult for one who has not visited it to realise that, in spite of its many natural drawbacks, it affords sustenance to a human population of exceptionally fine physique, and is the breeding ground of some of the finest races of cattle and horses and of the best camels in India. The bullocks of Nagore are celebrated for their size and paces; the endurance of the horses of Malláni is proverbial; while the swiftest riding-camels in India are born and bred in Bikanir. It is perfectly wonderful to see the apparently bare barren plains from which these animals contrive to pick up their daily food.

Nothing has hitherto been said of the cryptogamic vegetation of Rajputana. As might be expected, the richest spot in this respect is Aboo; but even there only about a dozen species of ferns occur, and of this small number only *Adiantum caudatum*, *Adiantum lunulatum*, *Cheilanthes farinosa*, *Nephrodium molle*, *Nephrodium cicutarium*, and *Actiniopteris radiata* can be said to be abundant. *Adiantum Capillus-Veneris* is found in a few spots, and *Botrychium virginianum* is very rare. Of mosses there are a few which, during the rains, form pretty tufts and festoons on the branches of the trees on the south-western slopes of the mountain, but at other times they are shrivelled and brown. There are a good many lichens on the trees and a few on the rocks. *Algæ* are not numerous. During the rains a good many *Fungi* spring up on decaying wood, and an edible *Agaricus* is found on grassy banks; *leaf fungi* are few in number.

In the eastern tract, the only ferns ever seen are *Adiantum lunulatum* and *caudatum*, *Nephrodium molle*, and *Actiniopteris radiata*. The latter is found only on walls, where it is associated with *Funaria hygrometrica*, the only moss at all common in the region. These species occur very sparingly, indeed, in the western tract, and only in shady crevices of rocks or on old moist walls. In wells, the maiden hair, *Adiantum Capillus-Veneris*, is occasionally met with on both sides of the Arvalis.

As has already been remarked, the province of Rajputana does not possess a flora peculiar to itself, but rather presents a field on which the adjacent floras of dry India and of the deserts of Western Asia and Northern Africa interosculate. In other words, there are, so far as the writer is aware, no species peculiar to this area, every plant in it being found also either in the adjacent provinces of Central India, Guzerat, the Punjab, North-Western Provinces, or in the dry regions of the Deccan and Southern India; while several of them occur also in countries far beyond the limits of the Indian Empire.

Extracts from the Report of the Royal Gardens at Kew for 1877. By Sir J. D. Hooker, K.C.S.I.

Boxwood.—For some years past the supply of this important wood has diminished in quantity and risen in price. It is derived from the forests of the Caucasus, Armenia and the Caspian shores. The wood of best quality comes from the Black Sea forests, and is principally shipped from the port of Poti. The produce of the Caspian forests, known in the trade as "Persian" wood until last year, was also exported through the Black Sea from Taganrog. This found its way after the commencement of the war, *viâ* the Volga Canal, to St. Petersburgh. The produce of the Caspian forests is softer and inferior in quality to that of the Black Sea. It is a matter of interest to see whether one result of the war will be to open those Black Sea forests which the Russian Government has hitherto kept rigorously closed. The falling-off of the supply has led meanwhile to various attempts to find substitutes for Boxwood for many purposes. Messrs. Joseph Gard-

ner and Son, of Liverpool, have introduced with some success Cornel (*Cornus florida*) and Persimmon (*Diospyros virginiana*) for shuttle-making, for which purpose hitherto Box has been in great demand.

Nan-mu Tree of Chinese.—Dr. Brandis has drawn our attention to a passage in Mr. Davenport's report on Yunnan [Parliamentary Papers, China, No. 2 (1877,) p. 13,] giving an account of the "Nan-mu" tree, the wood of which is so highly valued by the Chinese. If it could be accurately identified, the cultivation of the tree would no doubt be very profitable in India, and I, therefore, place on record what has been ascertained respecting it. The following is from Mr. Davenport's report:—

"This part of Yunnan (which seems to be between 25° and 26° N. lat.) produces the famous Nan-mu, so highly esteemed by the court for building purposes, and by the wealthy for coffins, on account of its durability. This timber is to be seen in perfect condition after the lapse of nearly three centuries in the shape of enormous pillars in the tombs of the emperors of the Ming dynasty, and has usually been supposed by foreigners to be Teak. The tree is tall, thin, straight growing, having no bough or twigs on the stem, but suddenly shooting out branches at the top, somewhat like a canopy over a maypole. Its bark is of a peculiar ashy grey colour, and a specimen of the leaves, gathered by myself, accompanying this report, will prove beyond all doubt that it is not a member of the Teak family.

During the Ming dynasty this wood had already become scarce (having probably been everywhere cut down and not re-planted), and was brought chiefly from almost inaccessible valleys inhabited by wild tribes. The imperial palaces at Pekin were built almost entirely of this timber.

At the present time this wood is imported into Shanghai in planks, measuring 8 feet long by 13 or 14 inches in diameter, for which the highest price is 200 dollars per plank. Whole coffins range from 100 dollars to 800 dollars.

The quality is judged of chiefly by the pungency of the scent. The leaves sent by Mr. Davenport to the Foreign Office cannot now be traced, but by the courtesy of E. Brad-

ford, Esq., late Master of the Apothecaries' Society, to which the specimens of drugs collected by Mr. Davenport were sent, I have been favoured with a further fragmentary specimen transmitted by Mr. Davenport, and also with specimens of the wood brought to this country by Wm. Lockhart, Esq., who states that "it is also used largely by Chinese gentlemen who take a pride in their libraries to make boxes for sets of volumes, and also to place between sets of volumes."

The leaves are too slender a basis for a certain botanical determination in the absence of flowers and fruits. But it appears extremely probable that the tree belongs to the family *Lauraceæ*, and the leaves themselves agree very closely with those of *Phœbe pallida*, Nees.

West Indian Forests.—Although scarcely falling within the province of this report, I cannot but record a word of warning as to the utter apparent absence of any restriction upon the destruction of the forests of the West Indian Islands, which must, as in some cases has already proved to be the cases, be injurious and even disastrous to those colonies.

With respect to Jamaica I extract, from a paper communicated to me by Mr. Thomson, the following particulars, which I think speak for themselves :—

"In certain localities hundreds of thousands of acres have been converted into desert by the wholesale destruction of the forests. In other localities hundreds of thousands of acres would, from the same cause, now be utterly unproductive, but for the interposition of foreign trees, [Logwood, Mango.]

"In consequence of the facility with which land is everywhere obtainable in Jamaica, the peasantry cut down annually 40,000 acres of forest land and thick bush on which to plant yams and other provisions. Innumerable timber trees, young and old, are thus yearly destroyed. These clearances are made in the most seasonable districts, and in many instances the excessive rainfall in such districts is perceptibly diminished in consequence of the large extent of these clearances. No conservation of the forest having ever been attempted here, the result is, as regards timber, that the resources of the island are practically nil. There is indeed some timber in the

inaccessible hills of the interior. Nearly all the timber required for building purposes is imported into the island, the annual value of which amounts to about 50,000*l*. Even the sleepers lately used for laying down the few miles of tramway in and near Kingston were imported. The unproductiveness of the island regarding timber is further to be deplored when our luxuriant tropical resources are borne in mind, and also when it is remembered that only one-thirtieth of the island is devoted to agricultural operations. In the event of any considerable advancement being made in the prosperity of the island, a very large expenditure would be entailed for the importation of timber."

The following extract from a letter received from Dr. Impray, equally seems to me to show the necessity of some forest supervision in that island :—

"*Pimenta acris*, (Black Cinnamon or Bois d' Inde), one of our most valuable timber trees, is being fast exterminated. We have no forest law, and the valuable timber trees of the island are cut down remorselessly, small and great, and of course none are re-planted. From the leaf of the *Pimenta acris* an essential oil is distilled, of which the far-famed (in America at least) Bay-rum is made. This perfume is used all over the United States. I believe there is almost a prohibitory duty on the oil, but it is smuggled into the country. Here the material will soon be exhausted, as the leaves are purchased at so much a hundred weight, and the negroes are cutting down all the young Black Cinnamon trees wherever they can get at them to secure the leaves.

Wood for Coffins in China.

It is well known that large sums are spent by the wealthy classes in China on certain rare and valuable kinds of wood for coffins. A considerable trade in woods for this purpose is being carried on, chiefly from Yunnan and other provinces of South China, northwards. Some time ago an English Missionary, travelling from Shanghai to Bhamo, met the Governor of a province on his way to Pekin, who was accompanied by strings of horses carrying planks of wood to give as presents to his

friends to make coffins. A collection of ten different kinds of woods used by the Chinese for coffins was lately sent to Kew by the Colonial Secretary for the Straits Settlements. All these woods were of the same good character, rather soft, very fragrant, and some with a fine silky grain. The prices are remarkable, ranging from a few pounds to £150. The extreme prices are almost fabulous; one case is reported of a coffin for a Mandarin, costing £600, and made entirely of wood.

One of the most valuable of these coffin woods is the Nan Mu, which grows in Yunnan, a tall tree with straight and clean stem, similar in general appearance to the wood oil trees of Burma. This tree has erroneously been identified with *Xylia dolabriformis*, the Pynkado of Burma. It probably, however, belongs to the family of Laurineæ.

The fragrant woods from Tavoy and Mergui, belonging to the genus *Cinnamomum* which were sent to the Paris Exhibition by Major Seaton, seem to be similar to some of the woods used for coffins by the Chinese, and they are again very similar to the Nepal Camphorwood, the Malligiri or Gunserai of Northern Bengal and Assam (*Cinnamomum glanduliferum*)—D. B.

On the Cinchona Plantation at Thantoungyee, E. Burma.

By the late Mr. S. Kurz.

HAVING visited last week the Cinchona plantation on Thantoungyee hill at your request, I have now the pleasure to submit to you the present memorandum.

From the few observations made with inferior instruments, the temperature appears low enough, although the place lies only about 3,800 feet above sea, to guarantee the growth of Cinchona at Thantoungyee. The atmosphere, however, will turn out to be too dry during the hot season. This is fully confirmed by the vegetation that covers these ridges. The forests there are evergreen forests, belonging to the variety, which I designated in my letter to the Conservator of Forests, British Burma, dated 29th May 1868, as UPPER DRY FORESTS. They consist chiefly of *Schima Noronhæ* and *Sch. oblata*,

Myrica Nagi, *Albizzia stipulata*, *Helicia robusta*, *Quercus dealbata*, *Eurya japonica* and one or two other species, *Garcinia anomala*, an arboreous *Saurauja*, *Pyrenaria camelliæflora* in abundance, *Ternstroemia japonica*, *Anneslea monticola*, *Calophyllum spectabile*, *Pithecolobium sp.* (near *P. angulatum*) and another leguminous tree only found in leaf but very similar in habit to *Albizzia lucida*, *Dillenia aurea*, a probably new species of *Castanopsis* in great abundance, *Bischoffia javanica*, a large-sized bamboo called 'Kyellowa,' *Beilschmiedia*, *Turpinia nepalensis*, two arboreous species of *Araliaceæ*, *Podocarpus neriifolia* and a few other trees in less abundance. Along the choung appear a splendid *Livistona* and *Pandanus furcatus*, the latter in large number. Of creepers and climbers are especially seen—*Mucuna macrocarpa*, *Rubus rugosus*, a climbing berry-bearing bamboo, here called 'Wathabwot,' but different from the one so named in the Pegu Yomah, three or four species of *Vitis*, amongst them an *Ampelopsis*, a fine *Calamus* possibly new, with the leaves white underneath, *Smilax lancifolia*, a *Bauhinia*, *Cnestis ignea*, *Lygodium polystachyum*, *Stenochlæna scandens*, etc. The undergrowth is chiefly composed of *Areca triandra*, *Melastoma malabathricum*, *Wallichia caryotoides*, *Maesa ramentacea*, a species of *Camellia*, *Tabernaemontana*, *Psychotria*, *Leea Staphylea* (?), a *Wendlandia*, etc. The herbage covering the dry ground is composed of *Strobilanthes Brandisii*, and locally of *St. pentstemonoides*, *Peliosanthes macrophylla*, *Tupistra nutans*, *Ophiopogon*, *Carex*, *Commelyna obliqua*, *Polygonum chinense*, a large *Phrynium*, *Alpinia nutans* and some other plants now without flowers or fruits, a species of *Pollinia* locally forming pasture grounds, *Dianella*, a large *Osbeckia*, *Molineria recurvata*, a fine large *Begonia*, *Lepidagathis*, and a number of ferns such as *Pteris aquilina*, *Aspidium*, *Nephrodium* and *Gymnogramme decurrens*. The stems of trees are but sparingly covered by mosses, but rich in cortical lichens, and, at my visit, were a good deal dried up, even as the *Hymenophylla*, *Xyris Wallichii*, *Asplenium laserpitiifolium*, *Niphobolus* and *Pleopeltis*, which are found frequently along with them. On granitic rocks, *Xyris Wallichii*, *Sonerila secunda* and *Didymocarpus mollis* are frequently seen. The ground is, during the hot season, densely

covered by dry leaves, &c., and jungle-fires enter these forests with as much facility as they enter the leaf-shedding forests of the lower regions. In fact, a large jungle-fire that broke out during my stay at the plantation, has shown me fully the destruction to which these forests are subjected during the hot season. The devastation by fire here is quite equal to that experienced in the plains, and where the large bamboo prevails even more fearful.

The soil is a light red soil, no doubt the result of decomposition of felspar of granitic rocks, with a great preponderance of rather coarse quartz-sand. The surface-soil is only to a very small depth, nowhere exceeding a foot, discoloured either by the decomposition of vegetable parts, or by the ashes of burnt-down vegetation. Huge rounded granitic rocks are seen here as everywhere in the Karen hills, striking out from the ground, or lying loosely on or along the ridges, or carried down to the choungs.

I should think that the locality was an excellent one for the cultivation of tea, and I am still more supported in my belief by the fact that nearly three-fifths of the forest trees forming these jungles are of the same family to which the tea-plant belongs, *viz.*, *Ternstræmiaceæ*. Besides, a species of *Camellia*, most probably identical with the Assam tea-plant, is found here plentifully along the Paloun, a choung which flows through the Cinchona plantation. But not a single kind of *Rubiaceous tree* was observed by me during my few hours' ramble through the surrounding forests.

The Cinchona will, no doubt, thrive here; but the question is, whether the cultivation at this place will really turn out remunerative. The trees will attain the same height and growth as the trees now composing these forests, that is, they will remain stunted and branched. Meanwhile, should they be planted along a choung in a deep alluvium, resting on primary rocks, it would cause the plants to grow up to be large-sized trees. It is for the latter reason that I should give preference to a formerly selected locality at Plumadoe, although I admit that the absolute elevation of Plumadoe valley is not sufficiently high (only about 2,200 feet). In my opinion, Cinchona would

thrive best in those forests, which I have mentioned in my letter to the Conservator of Forests above alluded to, as UPPER MOIST FORESTS, occupying the valleys and north and north-east faces of ridges, at elevations from 3 to 6,000 feet. The absolute height and depression of temperature caused by it are of little value, if not accompanied by a corresponding degree of dampness of the atmosphere. Nor is it absolutely necessary to go so high up the hills to obtain a temperature suitable for the cultivation of Cinchona. In fact, it is well known, and all my observations in Burma and elsewhere in India have taught me that valleys are much cooler and moister than ridges and summits of hills; so much so that, for instance, the temperature of Bogelay village at 3,000 feet elevation is more than 3 degrees higher than that of Palawa Zeik in Toukyeghat, hardly 500 feet above the sea. Unfortunately, there are no complete thermometrical observations at my disposal, either of Thantoungyee or of Plumadoe valley which could enable me to compare these two localities from a climatological point of view.

Dated Camp Otdweng, Toungoo, the 26th April 1871.

The function of the Pines and the Larch in the Production of soil.

(*Continued from page* 187.)

Of the three species of Pine which, in Europe, are found in cold climates—one, the *Pinus sylvestris*, is widely distributed; the other two, *P. montana* and *P. Cembro*, are very rare. The Larch is associated with these Pines either towards the pole or on lofty mountains.

The most important of the European Pines is, undoubtedly, the *P. sylvestris*, or 'Northern Pine,' known also by other names taken from the different localities in which it occurs, such as 'Auvergne, Briançon, Haguenau, Riga, Scotch or Norway Pine.' It is easily recognized from some distance by its ashy green-grey foliage, the colour of which is caused by the short light-coloured needles. The cones and the bark of the base of the stem have also a grey tint, but the higher portion of the bole,

and the point from whence the branches proceed, are distinguished by the characteristic bright red colour of the bark. This Pine is remarkable for the widespread area of its distribution. Found both in the plains and in the mountains, it advances from the extreme north of Europe to the southern regions, from the Icy Sea to the Mediterranean. On the Baltic Coast it forms, so to speak, one immense forest of 50 millions of hectares. As much again is found on the plateau of Central Russia, and the range of the tree extends thence beyond the Ural Mountains into Upper Siberia, so that it may be called the tree of the Northern deserts. In the valley of the Danube it is only met with in the mountains; in the Alps it is sometimes found at great elevations on southern exposures, owing to the protection afforded by the great mountain chain; in the Pyrenees it still forms forests at 1,500 metres, rising gradually thence to 1,800 metres, and extending itself westwards into the Basque region. Thus, passing from the north to the south of Europe, the elevation of the station of this Pine rises gradually, and seems in each region to be comprised between extreme altitudes of about 600 metres apart. Taken as a whole, the area of the home of the *Pinus sylvestris* presents the figure of a vast ellipse, having its centre in Russia, its greater axis passing between Moscow and Berlin, and its lesser axis extending from Lapland to the Black Sea. It is, however, restricted to poor soil, and especially to silicious sand.

In such a soil, the conditions of vegetation are difficult, and few forest trees can easily accommodate themselves. Unmixed with other species, the vast northern Pine forest, the 'bŏr' of the Russian plains, has a peculiar and wonderful appearance; the forest mass thin and with scattered trees is open on all sides to the light; and the soil, arid or peaty, only covered with dead pine needles, or with a carpet of bilberry and heather bushes and long thin erect-stalked grasses. Further south the Pines are mixed with Oak and Birch, the white bark of the latter forming a vivid contrast with the red boles of the Pines, and the brown oak trunks. In these forests animal life is scanty and silent, the presence of roedeer or the woodpecker here and there met with only serves to render the profound solitude more striking.

In mountain localities the Pine is often found in company with the Birch and the Silver Fir; these trees, by the thick cover they give, preserve the freshness of the soil, while the Pine, with its light foliage, overcovers them and thus forms trees of splendid form and magnificent bole.

The Scotch Fir requires abundant light for its growth. In the northern regions, where the summer nights are very short, it has full light almost without break during the season of vegetation; in the almost rainless plains of the Volga the dry pure air permits a strong light to reach the ground; and in the mountains of France it is found on southerly and westerly slopes, facing the Beech, the Silver Fir and the Larch, which usually cover those towards the north and east. Of all our forest trees, it is the one which best resists wind, provided it is not constant and cold, provided it is not damp.

In form the Scotch Fir varies exceedingly; it nevertheless is always *a tree* and never degenerates into a bush as do the Beech, Spruce, Birch and Mountain Pine. Even in Lapland, on the Tana, the most northern river of Europe, beyond the 70th parallel of latitude, it still forms trees capable in size of furnishing building timber, but still varies much in shape from the short, knotty, much branched and gnarled tree to the lofty mast-like straight growing Pine, whose summit ends in a narrow cone with only thin short branches.

Trees of this type, however, are always exceptional, even in suitable localities, and fine specimens over three centuries in age and capable of giving first-class mast timber are no longer seen. The type of tree, too, seems destined to disappear from the forest of Europe, where it formed such a magnificent spectacle of vegetable growth, but a few fine young trees of it are still to be seen in certain localities, such as in Italy and at Pustelnik in Galicia.

The best forests of *P. sylvestris* which France possessed were lost with Alsace-Lorraine. In the central plateau only a few still remain, such as are seen in the gorges of the Allier, although the mountains of Auvergne might easily be covered with them. A few fine trees may still be found in the Alps, but they are getting rarer and rarer every day in the forests of Provence,

Dauphiné and Savoy. In the Pyrenees the Scotch Fir is rarely found except as isolated trees; however, in the valley of Capsir, at an elevation of 1,540 metres, on the banks of the Aude where there is merely a small brook, surrounded by lofty mountain crests which shelter it on all sides, is an almost pure forest of Scotch Fir called the forest of Mattemal. In that station, on a platform of diluvium forming a terrace on the banks of the Aude, may be found trees of two hundred years of age, with a diameter of 0·65 centimetres, and stems capable of giving 17 metres of building timber. On this little plain, cut off from the plains of France by the still inaccessible gorges of the Aude, the trees have but very slight value, but great utility; the wood cannot be extracted, and without trees the country would be uninhabitable.

The *Pinus montana* is first found with the Scotch Fir in the forest of Mattemal in the Pyrenees, and it is also in that region found on the granitic slopes of Capsir, Roussillon and Cerdagne round Mont Louis. In the Alps, as in the Pyrenees, its home is at an elevation of 2,000 metres, but its elevation varies from 400 to 500 metres lower to the same amount of higher altitude, provided it is in favourable localities. It is not possible to mistake this Pine, whose bark is uniformly grey, from the Scotch Fir which has invariably some shade of red on the stem, or at any rate at the point whence the branches begin to spring, and merely from appearance there is no difficulty in distinguishing them, for the Mountain Pine is a tree of an aspect quite different from that of the Scotch Fir, being erect, pyramidal, with numerous close short branches, growing slowly, and rarely reaching any considerable size. In the Alps it is called *suffin*, and a tree of 40 to 50 centimetres in diameter is considered a fine specimen, though sometimes, as in the communal forest of Lian in Cerdagne, a larger size, and sometimes even double, is met with. Either above or below its proper locality this Pine degenerates and becomes deformed. On the uncongenial soil of torrential deposits on which the Mountain Pine is sometimes found at the bottom of valleys, it degenerates into a bush or rather a mass of thin closely-formed stems, and this is the form which has been called *Pinus Mugho*. At the upper limit of forest vegetation,

and especially on the northern slopes of the Swiss Alps, it is found growing prostrate or trailing over the ground, which in this way it shelters well enough, and from which circumstance it is called *zwergkiefer* or *legföhre*, the 'branching' or 'prostrate' Pine. Botanists have also called it 'Pin à Crochets' in consequence of a curious sport of the scales of the cone which are often curved back in the form of a hook. The cone of this Pine is also distinguished by its shining surface from that of the Scotch Fir which is grey and not polished.

The foliage of the Mountain Pine is also of a much darker green than that of the Scotch Fir, and this difference of tint permits us readily to distinguish from a considerable distance, often of several kilometres, the horizontal line which separates the two species in the same hill side where the Scotch Fir covers the lower, and the Mountain Pine the higher slopes, the latter usually higher than 1,700 metres. Besides the localities in France the Mountain Pine occurs also in some places in the Carpathian and Sudetian Hills, and in the Caucasus. As regards soil, it has no special predilection, as it may be found equally in limestone or sand, in dry soils or in marshy bogs, sometimes it appears, being then more or less of a botanical curiosity, accompanied by a few miserable stunted Birches, in the great masses of high regions, such as the Jura, the Vosges and the Black Forest, at a considerable distance from the original localities where its growth is abundant.

(*To be continued.*)

Wattle-Tree Cultivation.

A CORRESPONDENT, who a short time ago sent us his views on Tasmania as a place of settlement for Anglo-Indians, writes :—

"When on a visit to Kodi-Kanel, a few months ago, I was much struck at seeing how deeply-rooted the 'Wattle Tree' had become. The curse of this tree is well known, particularly in Tasmania, where one can see hundreds of acres of valuable cultivable land crowded with wattle, which nothing will kill, except dragging them up by the roots when they are young, care being taken that the root is not broken. The process of

grubbing up the young wattles is an expensive and tedious one. The earth round the roots must first be loosened by the use of a pick, then a horse or pair of bullocks are chained on to the butt-end of the tree, and drawn in the direction the root is growing. In this manner, roots 15 to 20 feet long, carrying on an average, a young tree to every foot of root, are dragged out without being broken.

"It may not be known by many, who are now doing their best to destroy the wattle, that the bark of that tree is most valuable for tanning purposes. When the discovery was first made some eight years ago in Tasmania, quite a rush was made in all parts of the country by speculators from Hobart Town and Launceston, who bought up all the wattle shrubs from the squatters, who were glad to sell the bark at five shillings an acre; and in the course of three years, the speculators were glad to buy the bark at £2 an acre. The process of stripping the trees simply requires a ring to be cut into the wood at the butt-end of the tree, when the bark is pulled off in strips by a number of boys, who are able to climb up the tree, so as not to break the strip, and also to strip the tops of the trees, where the best bark is to be found. The strips are tied in bundles by women, and stocked in certain small depôts by men, where the bark is left for some time to dry in the sun. It is then carted away in large six-horse waggons to either of the two towns, where it is crushed at the steam mills; and eventually a large quantity is shipped to England and the other colonies. At present the bark is worth as much as £5 a ton—so that it is not only a source of revenue to the farmer as long as he has trees to strip, but in another respect; the bark having become valuable, has been the cause of his being able to get his land cleared for little or nothing; because, as the stripped trees generally die, the contractors are made to cut them down; they are then heaped in large stocks, and when thoroughly dry are burnt; whereas, perhaps, for years, the farmer has seen his land gradually becoming a wattle scrub, the growth of which he was unable to cope with. In Victoria, in consequence of the cheap and abundant supply of wattle-bark, now acknowledged to be by far the most powerful tanning bark in the world, the export

in leather trade has within the last seven years largely increased. The exportation of hides has nearly ceased, while the number imported during the seven years were 392,228. The total value of leather exported during the seven years was £1,532,703, exclusive of the amount required for consumption in the colony. In 1870, the amount of bark exported was only 1,384 tons, representing £6,418, while in 1876 the exportations amounted to 9·724 tons, the aggregate value being £60,386. As the wattle tree grows very quickly, and seems to flourish so remarkably well at Ootacamund and Kodi-Kanel, it would be worth Government's while to try an experiment at plantation, on the formation of which the following few suggestions may be useful :—

"There are three species of wattle, namely *A. pycnantha*, commonly known as 'broad-leaf,' 'golden,' and 'green;' *A. decurrens*, or black wattle; and *A. dealbata*, or silver wattle. The bark of the first is superior to any other, but the tree is of slow growth, and does not attain such large dimensions as the black and silver species. For tanning purposes the silver wattle is generally discarded. The black wattle is of vigorous and robust habit, and for commercial purposes is equal to the broad-leaf species. September, October, November, and December ought to be the stripping season. In all cases 'stripping should be thorough, as the higher branches often carry the best bark, and under no circumstances should any bark be left on the tree.' The wattle requires little attention in cultivation. Its wood can be readily utilised for cask staves, axle spokes, axe and pick handles, and many other articles requiring a tough, durable grain, and when dried it is an excellent firewood. A good profit also may be derived from the sale of the gum which exudes from the trees which yield a percentage of tannin, but they can never replace the wattle. The bark from trees growing on a limestone formation is greatly inferior in tannin. One of the largest black wattles met with gave a mean diameter of 24in., its age being 18 years. The wattle is at its prime at 10 years. After that the tree loses its vigorous, healthy habit, and is usually attacked by disease or insects.

"Wattles grow on almost any soil, but their growth is most rapid on loose sandy patches, or where the surface has been broken for agricultural or other purposes. Where the soil is hard or firm, it is recommended that plough furrows should be made at regular distances of say 5ft. to 6ft. apart, into which the seeds are to be dropped. The outer covering of wattle seed is peculiarly tough, hard and horny in character, thereby forming a protection which renders the seed comparatively impervious to ordinary germinating influences. It will, therefore, be found necessary to employ a more direct agency than simply covering the seeds with earth. Water, of a little less than boiling temperature, should be poured on the seeds, and they may then be allowed to soak in the water until soft. As the seeds are small, and ought to be sown near the surface, a very light sprinkling of earth will suffice. It would be sufficient for all practical purposes of cultivation to drop the seeds at average distances of 1 foot apart along the furrows, in which case about 7,200 seeds would suffice for an acre of land. The wattle seed is, however, inexpensive, being obtainable in most districts for the mere trouble of collecting, or it can be purchased for 8*s.* or 10*s.* per lb. There are about 40,000 seeds of the *Acacia decurrens*, or black wattle, to the lb., while the seeds of the *Acacia pycnantha*, or golden wattle, are one-fourth heavier, and consequently represent not more than 30,000 to the lb. The seeds can, therefore, be dropped along the furrows at much shorter distances, and the seedlings thinned out at discretion, whereby the chances of a regular plantation would be increased. On loose, sandy soil, on which *Acacia pycnantha* can best be raised, it might not be even necessary to break up the soil in any way; but it should be borne in mind that any opening up of the surface would materially accelerate the germination of the seed and subsequent growth of the seedlings. On such open sandy soil the straight furrow line may be dispensed with and the seeds scattered broadcast. When the young trees have attained the height of three or four feet, the lower branches should be pruned off, and every effort afterwards made to keep the stems straight and clear, in order to facilitate stripping, and induce

an increase in the yield of bark. In all instances where attention is paid to the cultivation of wattles as a source of income, care should be taken to replace every tree stripped by successional sowings, in order that there should be as little variation in the yield as possible."—*From the 'Madras Mail,' October* 18, 1878.

The Forests of Cyprus.

From "Gardeners' Chronicle" of July 27th, 1878.)

As already stated, some writers who profess to write for the public information have imagined forests of Pine, Beech, &c. Unfortunately forests of any kind of tree are exceedingly limited in area, and chiefly confined to the inaccessible parts of the mountain chains; and as for the Beech, there is no record, we believe, of its ever having been found in the island.

Formerly, it is true, Cyprus was covered with forests, and was noted for its excellent timber; but according to Unger and Kotschy there is no doubt that then, as now, the forests consisted principally of Pine trees. From the sea-level up to 4,000 feet *Pinus maritima* prevails, and above that altitude it is replaced by *P. Laricio var. Poiretiana.* Even now it is possible to trace the earlier distribution of these two Pines, and see that the Pine forests were only interrupted here and there by other trees. Although the work of devastation has been carried on very recklessly, there still exist some beautiful though thin forests of *P. maritima. Europhaca boetica* flourishes only in the shade of this Pine, and *Quercus alnifolia, Arbutus, Andrachne,* and *Acer creticum* are often associated with it as underwood, sometimes straying beyond and forming independent copses. The forests of *P. Laricio* are nobler and undisturbed, because they are in less accessible situations. This Pine clothes the heights of Troodos, Adelphos, and Machera, and these alone. Few flowering plants flourish underneath the Pines. One of the most conspicuous is the beautiful *Pæonia corallina,* and *Limodorum abortivum* pushes forth from the decaying bed of Pine foliage. *Juniperus fœtidissima* is associated with the Pine on and near the summit of Troodos, to which also *Berberis cretica* penetrates. Only the

two species of Pine named occur in the island. *Cupressus horizontalis* and *Juniperus phœnicea* are rapidly disappearing as forest trees, though the latter spreads as a shrub where the maritime Pine makes room for it. *Quercus inermis* and *Q. Pfæffingeri var. cypria*, the only arborescent species of Oak, are now quite rare as trees, and can never have had any considerable distribution in the island. *Platanus orientalis* and *Alnus orientalis* exist only by the side of the beds of streams; and *Cratægus Aronia* and *Pistacia palæstina* are rapidly disappearing, fine specimens being quite rare. The general character of the flora is quite Mediterranean, as distinguished from Syrian. One of the most noteworthy features in this is the prevalence of needle-leaved trees in Cyprus, whereas in Syria these are re-placed by flat-leaved trees. A considerable proportion (4·2 per cent.) of the species are peculiar to the island, at least they have hitherto not been found elsewhere. Of these, eleven are *monocots* and thirty-one *dicots*—two *apetalæ*, sixteen *gamopetalæ*, and thirteen *polypetalæ*. Amongst the most noteworthy are *Quercus alnifolia*, which represents *Q. Ilex; Q. cypria, Ballota, integrifolia*, a spiny species; *Pterocephalus cyprius, Salvia cypria, Galium suberosum, Ornithogalum pedicellare, Silene lævigata, Gladiolus triphyllus, Colchicum Troodi, Crocus cyprius, C. veneris, &c.* The bulb flora, it may be repeated, is still very imperfectly known.

Bamboo as a Paper-making Material.

TO THE EDITOR OF THE "INDIAN FORESTER."

DEAR SIR,—I have only just received your Journal for April, and perceive you have kindly inserted therein my letter on Mr. Smythies' experiments on Bamboo in the Central Provinces. From fortuitous circumstances, due mainly to Bamboo being a tropical product and failing supply, I regret to say I have been unable to progress much further in experimenting on its manufacture into "Paper Stock," the long-continued commercial depression being deterrent on any new enterprise in India. I am, however, daily looking for an arrival

of some thousands of stems collected for me by Government in Burma to be crushed at Rangoon by the rolls I sent out, and also some few tons from Jamaica collected for me by Mr. Robert Thomson, the author of the letters I inserted in the Society of Arts' Journals of January and March last.* I mail you herewith, and you will confer a favor if, to keep this important subject alive and promote discussion and attention, you will insert their letters in your next issue.

Mr. Thomson is again in England, and his further investigations more strongly confirm the conclusions therein referred to: placing the cheap and continuous supply of this valuable paper-making material beyond dispute, and as I venture also to add that my experiments so far have proved its value as regards quality for the purpose, I hope ere long to find the subject will acquire the importance in our great Indian Dependency which I think it merits. In the persent somewhat hazy condition of European politics, not merely speaking selfishly, but in the interests of our English Paper Trade, I think it will be admitted it would be better we should draw our supplies of raw material from India than be dependent as now almost entirely on Esparto grass, the quality of which I may add is getting less and less reliable.

That judiciously and economically carried out the manufacture of paper stock from Bamboo will pay, and pay well, I confidently assert.

I will not fail to send you samples of the paper and paper stock from the Bamboos now in transit to our works so soon as they arrive, and remain meanwhile,

Dear Sir,
Faithfully yours,
THOS. ROUTLEDGE.

CLAXHEUGH SUNDERLAND,
17*th October* 1878.

* The first addressed to Sir Joseph Hooker, the second to Mr. Routledge.

CINCHONA PLANTATIONS, JAMAICA;
6th November 1877.

DEAR SIR JOSEPH,—I have thought of writing you for some time on the subject of your remarks, in your last annual report on Kew-gardens, on bamboo as a material for paper-making. I hope you will excuse the liberty I now take in submitting the views I entertain on this subject. I have taken much interest in this matter, and have been in communication for some time with the largest firm of paper exporters in America, with the object of establishing the export of the raw material from here on a large scale. I have also from time to time, in my reports to the Government, referred to bamboo as being one of the most important paper-making materials. And I may further mention that both the *European Mail* and the *Planter's Gazette* have recently noted the encouraging prospects that exist in Jamaica of establishing a large export trade in bamboo.

Cutting the bamboo stems *en masse*, as you have stated, would undoubtedly destroy the plants; but, with great deference, I would remark that this destruction of the plants can be effectually prevented by the adoption of a different process of cropping. Thus, instead of cutting all the stems simultaneously, a given proportion of matured stems should be retained, and this need only be a small proportion, sufficient to maintain the vigorous action of the roots. The stems thus retained for the preservation of the fructions of the roots may even be moderate in size. Indeed, they may be lopped so as to superinduce the sprouting of branches and foliage near the ground. Another point to be observed consist in the manner in which the young, succulent stems are cut. They should be cut—that is, the crop for making paper—not close to the ground, but a few nodes above the ground should be left. This plan ensures the sprouting of branches and foliage from some thus left, and maintains the unimpaired action of the roots.

The continuity of supply of the bamboo by the adoption of this plan aggregated to a very considerable quantity each year; and, as has been seen, a bamboo plantation may be kept up indefinitely in regard to time.

I have seen three tons of full-grown stems obtained from a bamboo clump, covering only a few square yards. This would be an enormous quantity per acre. By the system of cropping which I propose, each succulent stem, in that condition in which a penknife is easily passed through it, when dried averages only about three pounds in weight. As many thousands of these are obtainable per acre annually, I feel sure that some ten tons of paper stock could be procured from each acre annually; putting it even at the half of this, the cultivation would prove highly remunerative.

The system of reserving a due proportion of growing stems, by which systematic thinnings would be constantly obtainable, is so obviously advantageous, that I think it would entirely supersede the plan proposed by you, namely, growing bamboo like the sugar cane, and to replant after cutting the crop. Bamboo cuttings, though they root immediately, require to be planted a long time, certainly over two years, before they produce large and vigorous stems suitable for paper making.

It is a pity that some method could not be devised for utilising the ripe bamboo stems in paper manufacture. Some years ago hundreds of tons of the ripe stems were exported from here to America, which stems, I have been informed on reliable authority, were made into paper; this trade was brought to a close owing to some difficulties in the monetary affairs of the merchant in New York to whom the bamboo was consigned. An almost incredible quantity of ripe bamboo is procurable from each acre of land, and I find that the ripe bamboo is used in China for paper manufacture. In a most interesting "Catalogue of the Chinese Imperial Maritime Customs," collection of products at the Philadelphia Exhibition, published by the authority of the Inspector-General of Chinese Maritime Customs, the following account is given of the process of treating the bamboo stems:—"The method of preparation from bamboo is as follows: The bamboo is stript of its leaves and split into lengths of three or four feet, which are packed in bundles and placed in large water tanks; each layer of bamboo is then covered with a layer of lime, water is poured on till the topmost layer is covered. After remaining in this

condition three or four months, the bamboo becomes quite rotten, when it is pounded into pulp in a mortar, cleansed and mixed with clean water. This liquid is poured in quantities sufficient for the size and thickness of the sheets required, upon square sieve-like moulds. These sheets (of which a skilful workman can make six in a minute) are allowed to dry, then taken from the mould and placed against a moderately-heated wall, and, finally, exposed to the sun to dry. The best quality is made from the shoots of the bamboo, with alum added to the infusion; the second from the bamboo itself, though a higher grade of this quality is attained by the previous removal of the green portion."

I would add that the prices of paper made from the bamboo in China range from 3 dols. 61 cents. to 21 dols. per *pecul* (133⅓ lbs.).

I remain,
Dear Sir Joseph,
Yours truly,
ROBERT THOMSON.

To SIR JOSEPH HOOKER, F.R.S.,
Director, Royal Botanical Gardens,
Kew.

DEAR SIR,—With reference to your letter of 30th December last, addressed to me in Jamaica, and which I only received a few days ago, it having been returned to me here from Jamaica, I beg to submit my further views on bamboo cultivation.

Jamaica has a very striking variety of climates in the lowlands more or less suitable for bamboo growth. This variety of climates has been caused by the improvident destruction of the forest. Bamboo on the drier plains presents a shrivelled and stinted aspect, except when within reach of water, which ensures its wonted luxuriance, it therefore assumes its greatest luxuriance in the most humid districts. Many hundreds of acres of certain districts are densely covered; for instance, a certain part of the parish of St. Thomas is literally covered with it. The plant flowers and yields seed in Jamaica under

very exceptional circumstances, so that seeds are rarely seen. I have never been fortunate enough to see it in flower. It has been widely distributed owing to the readiness with which cuttings grow in most climates. The ripe stems are commonly used to form fences, the post and rails consisting of the stems; the posts, if placed in the ground prior to the rainy season, take root, and unless they are frequently trimmed become irrepressible thickets. Ripe stems of medium size are not uncommonly used by the Negroes as poles on which to support each plant of Yam, which climbs over the pole in their cultivated "provision grounds;" these stems in like manner grow. This will explain the facility with which the plant is propagated—though it is likewise propagable by offsets or rhizomes, I think, however, the stem process of propagation would be in every respect preferable.

With regard to the question as to the period required to produce "crops by planting," I am quite sure that this period could not be diminished by planting offsets from established stools. It should be remembered that by any system of propagation of the bamboo, the first process of rooting is very simple; the result of the first roots is the production of slender, twiggy shoots, but as these latter become matured, the increased vigour of the root action creates stems with proportionately increased strength, and so on step by step until the fully developed stems are producible; the whole length of time, from the time of planting, as I have already mentioned, for the maturation of the crop being at least two years.

An individual stool, if influenced only by the ordinary rainy seasons, I think would not produce more than one crop in a season, but under a system of irrigation I am strongly inclined to believe that two crops would be producible. For the wants of the paper manufacturer it will no doubt be supposed that the available command of bamboo obtainable may be turned to account, instead of having resort to the formation of plantations. I will, however, briefly endeavour to show that a regular plantation possesses immense advantages. The existing bamboo, though only a few miles from shipping ports, is not so conveniently situated as it would be in a special plan-

tation, on which the most advantageous and accessible spots would be set apart and systematically planted in a series of plots, in order to facilitate and economise cutting and carriage. The advantages thus indicated would be considerable, but the great advantage of planting bamboo would be that of having it brought under the influence of irrigation, as it is peculiarly a water-loving plant.

It is well known that general crops of bamboo shoots are only produced after heavy rains, a fall of from 15 to 30 inches; such rains usually occur two or three times a year in Jamaica; the time young shoots take to spring from the ground up to about 25 feet (they are at this height in a fit condition for your requirements) after such rains averages five weeks. Irrigation would produce constant action at the roots, and there can be no doubt that by the process of cutting, which I advocate (*vide* my letter of the 6th Nov.), several crops a year may be secured; indeed, a continuous succession of cropping could be assured by systematic cultivation and irrigation.

To those who have not visited the tropics it is impossible to conceive the extraordinary luxuriance of this gigantic grass. The description you give in your valuable pamphlet is far short of its majestic grandeur.

In laying out a plantation, I think that cuttings should be set about four or five feet apart; thus by planting thickly the intervening surface would be expeditiously occupied by the stools, and this system ensures the benefit of fostering among the plants a reciprocal tendency to shoot upwards.

The cost of planting would be about £2 per acre. After planting, four or five weedings, costing ten shillings, would be given during the two years required to establish the plantation. Subsequently to this cultivation would be absolutely dispensed with, except the application of water and a judicious system of cutting out the stems.

The Government of Jamaica has constructed, at great expense, magnificent irrigation works on the St. Catherine Plain, surrounding Spanish Town, and as very little advantage has been taken of this precious adjunct to tropical agriculture, land is obtainable at a very cheap rate, and it is most conve-

niently situated, as the railway connects it with Kingston, only 15 miles distant.

The irrigation works are constructed to irrigate upwards of 14,000 acres, but only a few hundred acres of cultivation have actually been brought under the influence of this water. Labour would be abundantly obtainable at 1*s.* 6*d.* a day; hundreds of strong Negro labourers would be at command all the year round, and for rough and continuous hard work the Negro is far superior to the coolie, and they prefer any kind of work to sugar estates work.

The Government undertake to supply a quantity of water (as I mentioned in a previous letter to you) equivalent to a rainfall of 60 inches a year for £1 per acre per annum; this is very moderate, as it would certainly double or treble the crops of bamboo annually as compared with the ordinary seasons. The average rainfall of the locality in this irrigation scheme is about 40 inches.

Our bamboo is *Bambusa vulgaris*, but, of course, you are aware that all the varieties are most productive in localities in which moisture is most abundant. This is a most important consideration, in view of the production of bamboo in Jamaica, and one which has, perhaps, not received any attention; the variety of climate as regards moisture is very remarkable. The destruction of the forest in most parts has materially lessened the rainfall; certain districts are too dry for bamboo to exist in, others only afford sufficient moisture to maintain the bamboo in a condition of very partial luxuriance; it therefore follows that districts having a constant precipitation of rain, with a normal average of from 80 to 100 inches a year, are best adapted for this plant. Astonishing crops under irrigation, therefore, would be obtainable at a small cost of production, for it would require little or no cultivation beyond its first establishment.

I agree with you that it would not answer to export the bamboo in any other way than manufactured into paper stock, not only on account of the great difference in the cost of transport, but owing to the deterioration of the article in tran-

sit, when it is sent in a crude state, due to the difficulty in drying the young stems, even after crushing.

I may mention, that before your pamphlet was published I was impressed with the notion that bamboo was destined to become the most valuable of all materials for paper-making, by reason of the quantity of it producible per acre—a quantity of fibre far greater than can be produced from any other plant, a fact to which you have referred. It should be remembered that bamboo grows its whole height in a few months, that the great bulk of it is composed of fibre which is convertible into paper stock, and that it produces its stems so closely, that is to say, each stem about 60 feet high (*Bambusa vulgaris*) occupies about half a square foot. Thus it does not require, as you state at page 8 of your pamphlet, two feet; half a dozen at least grow within two feet. Indeed, I should scarcely like to say what quantity of bamboo may be realised per acre, but it may be safely predicted that it will be so large that it will revolutionise the paper trade.—Remaining yours truly,

ROBERT THOMSON.

11, QUEEN-SQUARE, BLOOMSBURY, LONDON,
22nd February 1878.

Utilization of Salei Wood for Sleepers.

(*From Indore Forest Report in the "Indian Agriculturist" of May* 1878, *p.* 170.)

Mr. Carey, the Chief Engineer of the State, reports:—

"*Forests.*—Since last year the jungles of the Bai districts have been added to my care; much fuel, teak bullies and logs for shoring up foundations of bridges have been supplied to the railways.

"Large quantities of bullies are being supplied to the Military Department, Indore, and to numerous village people for building their houses and for farming purposes.

"*Sleepers.*—Experiments have been and are being tried on railway sleepers; in February last year, six Salei sleepers were cut green and immersed in a tank (made expressly for the purpose) filled with Behera leaves and water; in the June following these sleepers were put down on the Neemuch State Railway, and are to this day as sound as the day they were put down. This wood was always considered next to useless, as being so readily attacked by insects, but five months' soaking in a solution of Behera leaves, whose tanning properties are well-known, has proved that sleepers can be obtained from this tree. We have vast quantities of Salei in our jungles, well grown, capable of making on an average quite 8 half-round sleepers from each tree; of course, time will test the life of these five sleepers; at present they look most healthy and promising, and if they turn out long-lived, we are safe to find a market on the

two lines of Holkar and Neemuch State Railways, and thereby make a good revenue.

"One hundred Salei sleepers were cut in June 1876, and laid in the Kanar river and left during this monsoon with the intention that all impurities should be soaked out in the running water; after the rains only, 49 sleepers were found; the rest had been washed away; these have been laid down on the Holkar State Railway by the kind permission of the Engineers; on trial they appear sound, but the action of weather and being constantly run over by trains will soon test their worth. We could supply Unjan sleepers, but they are worth more to us at the Indore market as logs than being cut up into sleepers; the rate for sleepers being rather at a low price."

THE

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The Banda Forests.

(By G. Greig, Esq., Conservator of Forests, Central Circle, N. W. P., dated February 23rd, 1878.)

The Bánda forests are confined to the three southern pargánas of Badausa, Tirohan, and Thán, the bulk of them being in Tirohan; they contain a variety of trees and shrubs (see appendix A.), and they are situated on low rocky hills of the Bundelkhand type: the top a plateau (pátha), the sides precipitous walls of rock (ári) from 50 to 300 feet high, and then a more or less gradual slope to the valleys.

The plateaux are, as a rule, fairly level, but some are undulating and on some are distinct little hills; most of them are totally uncultivated, but on a few there are villages: for instance, Panwari, Lakhanpur, Kulmar Parasin, Chaori, and Rajowan. With the exception of Kulmar Parasin, these are small poor villages, inhabited principally by Gonds and Kolis, who live in temporary hovels with thatched roofs, and have a constant struggle with nature, in the shape of poor soil, pigs, monkeys, and nilgái, to save sufficient of their wretched crops to keep themselves from starvation. These plateaux are generally fairly well covered with dawa, shéj, sándan (or tinsa), khair, saj, tendu, achar, salie, &c.

The precipices flanking the plateaux are very extraordinary and picturesque; the huge blocks of rock piled one above the other in all sorts of grotesque shapes and positions give them the appearance of enormous masonry fortifications in

ruins; various kinds of ficus grow along the tops of the "ari," their roots shooting through crevices of the rocks and hanging down the face of the precipices like so many ropes. The base of the "ari," being cool and moist, is generally well clothed with fine trees of many kinds and a few bamboos, with here and there dense thickets of the large-leaved creepers, mahwál and badrasin, climbing over huge masses of fallen rock, and forming quiet retreats for a few sambar and an occasional tiger after their nightly rambles. The only places I observed the reoni (*Mallotus phillippinensis*) were in cool moist spots at the foot of the "ari."

The slopes are almost invariably successions of terraces and slopes sparsely covered with inferior forests of khair, katber, dawa, &c., which are much injured by lopping for cattle and goats; lower down in the basins the forest improves, and the valleys are generally well covered with all the most useful kinds of timber trees.

As may be seen by the map, the railway from Allahabad to Jubbulpore runs right through the main portion of the forests. About 13 or 14 years ago, an enormous amount of wood was used in the construction of this line; the forests within ten miles or more of the line appear to have been clean swept of every tree except mahua, and although a coppice of about ten feet high has since sprung up, it is easy to see how the forest has deteriorated. Fires have destroyed many of the stools of the better kinds of trees, their places being now occupied by the hardy katber and jarber (*Zizyphas xylopyra* and *Jujuba*), and those that remain alive have been so injured that their shoots are thin and sickly-looking.

And this is what is still going on, more or less, in all but the more distant and inaccessible parts. A great deal of firewood is bought by contractors for brick-burning, &c., in Allahabad; building timber is cut anywhere and everywhere it is required; cowherds and goat-herds all carry axes and ruthlessly hack down trees right and left; and then come the annual fires, which either kill the stools entirely, or so injure and weaken them that only a small proportion of their coppice shoots grow into useful timber.

Under such treatment it is not surprising that the forests deteriorate; by the end of summer all leaves and other vegetable matters have been burnt, and the ground left perfectly bare and as hard as a brick. The monsoon breaks with a heavy downpour; it takes many days to soften the ground sufficiently to allow the rain to soak in as fast as it falls, and meanwhile the water is rushing off the hills in torrents, and carrying with it immense quantities of surface soil to the rivers below.

Slowly, but surely, does this go on year by year, and if some precautionary measures are not taken, the whole of these forests must disappear; the hills will become as barren as those about Morar and in parts of Jhansi, and then it will be almost *impossible to re-clothe them.*

As may be gathered from what has been already written, the first point to be attended to towards preventing the denudation of these hills is to put a stop to jungle fires; that is absolutely essential, and without it no improvement can be expected. Keep fires out of these forests for the next fifteen years, and the whole aspect of the country will be perfectly changed: the trees and grass will remain green until well on into summer; a thick coating of vegetable mould will be formed, which will keep the ground cool and moist; the rain will then percolate through the soil instead of rushing off in torrents and carrying soil with it; the temperature of the neighbourhood will be lowered, and dry watercourses will become running springs of pure spring water. This is a pleasant prospect compared to the other, but it is not, I think, exaggerated.

At the time of the last settlement, the advantages of forests were evidently not appreciated; they were treated as so much waste land, and were divided off amongst the neighbouring villages, to be used by the people without restriction according to their own lights. The results of this are now very apparent, and as that settlement has expired, and Government is now at liberty to do as it pleases, this is the very time to step in and prevent ruin.

The revenue survey map of 1840-41 of the Banda district is so utterly inaccurate regarding the waste lands that it is

impossible to compute the area; but the Collector estimates it at about 250 square miles, about 150 of which might be "closed to the people without serious inconvenience to their agricultural or pastoral wants."

Although it is impossible to say positively what that profit will be, I am inclined to think that, after a few years of proper management, not less than Rs. 8,000 to Rs. 10,000 a year may be expected; and, as the quality of the timber improves and the trade increases, the profit would, of course, increase also. As far as I could learn, the annual exports now amount to some 64,000 maunds of firewood (say 30,000 by rail and the remainder to local marts) and about the same quantity of building timber. If the small royalty of (say) half an anna per maund on firewood and one anna on timber was enforced, this alone would amount to Rs. 6,000; and besides this, there would be a certain revenue from wood supplied to villagers who have no forest rights, and from bamboos and other minor produce.

The mahua is the finest and most valuable tree in the district; it seems to thrive on the very poorest soil, and magnificent specimens are to be seen all over the country, but more especially near villages. The natives protect the mahua very carefully, and never allow a tree to be felled: its flowers form a staple article of food (and drink).

The most valuable timber trees are those mentioned in paras. 13 and 17; there are others—such as teak, dhaman, bija sál, &c.—which are of more individual intrinsic value, but they are so scarce that they are hardly worthy of notice. Those that I have classed "the most valuable" do not grow into large trees, as we find them along the foot of the Himalayas, but they grow straight and clean, and furnish excellent poles of from 6 to 15 feet in length.

Names of trees and shrubs.

Bánda vernacular name.	Sub-Himalayan, North-West Provinces' name.	Botanical name.	Remarks.
Tendu (ebony)	Tendu	Diospyros Melanoxylon ...	Fruit much eaten.
Salie	Not found	Boswellia thurifera ...	Yields a fragrant gum, used as incense in India, but not the olibanum of Europe.
Dháman	Dháman	Grewia vestita	
Khair	Khair	Acacia Catechu	Wood yields catechu.
Jáman	Jáman	Eugenia Jambolana ...	Scarce; a useful timber; fruit edible.
Aonla	Aonla	Phyllanthus Emblica ...	Excellent wood; fruit edible.
Renja	Not found	Acacia leucophlœa	Bark and seed edible.
Dubein	Ditto	Dalbergia paniculata	
Dhawa	Bakli	Anogeissus latifolia ...	Very plentiful; excellent building timber.
Sagon (teak)	Not found	Tectona grandis	Very scarce.
Báns (bamboo)	Báns	Dendrocalamus strictus ...	Not very plentiful.
Mahua	Mahua	Bassia latifolia	The finest tree in the district; the flowers are much eaten by men and animals, and are distilled into common country spirit.
Mahwál	Máljan	Bauhinia Vahlii	The elephant creeper.
Bél (bael)	Bêl	Ægle Marmelos	Excellent wood; the fruit is an excellent medicine for dysentery.
Semal (cotton tree) ...	Semal	Bombax malabaricum ...	Not plentiful.
Palás	Dhák	Butea frondosa	Yields "Bengal kino."
Pilu	Khumbi	Careya arborea	Bark used for ropes and matchlock fuses.
Karaunda	Karaunda	Carissa Carandas	Common; fruit makes a good preserve.
Bahér...	Bahéra	Terminalia bellerica... ...	Wood inferior.
Gúlar	Gúlar	Ficus glomerata	Woods used in wells; durable under water.
Shísham	Sissu	Dalbergia Sissoo	Very scarce.

Banda vernacular name.	Sub-Himalayan, North-West Provinces' name.	Botanical name.	Remarks.
Imli (tamarind) ...	Imli	Tamarindus indica	Not common.
Sirsa	Sirras	Albizzia Lebbek	Not common.
Tinsa or Sándan ...	Sándan	Ougeinia dalbergioides ...	Fairly common; excellent wood.
Jamrassi or Mamri ...	Not known	Elœodendron Roxburghii ...	An excellent timber and fairly plentiful.
Jamalgota	Ditto	Croton Tiglium	Very scarce; yields the croton oil of commerce.
Anjan	Not found	Hardwickia binata	A fine tree; scarce.
Achar or Chironji ...	Katbhilawa	Buchanania latifolia ...	Fruit much prized.
Haldu	Haldu	Nauclea cordifolia	A large tree; not very plentiful; yields good useful timber.
Kaim	Kaim	Nauclea parviflora	Very similar to the above.
Bija Sál	Bija Sál	Pterocarpus Marsupium ...	Very scarce; excellent timber.
Kusam	Gosam	Schleichera trijuga	Useful for sugar and oil-mills.
Kowa	Anjani	Terminalia Arjuna	
Sáj	Sein	Terminalia tomentosa ...	Fairly plentiful; excellent timber.
Gotaha	Katber	Zizyphus xylopyra	Fruit used as a black dye for leather; leaves much liked by cattle.
Bér	Bér	Zizyphus Jujuba	Fruit forms a staple article of food; leaves and fruit much liked by animals; an exceedingly useful bush.
Shéj	Dhaura	Lagerströmia parviflora ...	Excellent timber and plentiful.
Seina	Amaltás	Cassia Fistula	Good timber, but scarce.
Páper	Pápai	Pongamia glabra	A large tree; wood inferior.
Katyya	Not found	Not known	Of no special use.
Dudhi	Dudhi	Wrightia tomentosa ...	A fine grained wood; used in turning.
Gabdi	Kumbi	Cochlospermum Gossypium ...	Of no special use; wood soft and light.
Karbár	Thanella	Gardenia turgida	Common, but does not grow to any size.
Kulu	Not found	Sterculia urens	Wood soft and light.
Gurja	Kharpat	Garuga pinnata	Yields the gum "katíla;" not valued.

Bairi	Chilla	Casearia tomentosa... ...	Wood not valued.
Bhoti	Pátha	Kydia calycina	Wood close and straight grained ; not common.
Not known	Pádal	Stereospermum suaveolens ...	Not common.
Ditto	Reoni	Mallotus phillippinensis ...	Yields " kamela" powder ; very scarce.
Not known	Mainphal	Randia dumetorum ...	Fruit used to poison fish ; not plentiful.
Ditto	Marorphal	Helicteres Isora	A small shrub ; bark yields a strong fibre.
Ditto	Dhauldhak	Erythrina suberosa... ...	Wood used for scabbards, &c. ; not plentiful.
Ditto	Khairwál	Bauhinia purpurea... ...	Scarce.
Gánt	Gandla	Murraya Königii	Leaves used for flavouring curries.
Badrásin	Not found	Not known	A larged-leaved creeper.
Káphr	Ditto	Ficus	Common along the precipices.
Kinni	Ditto	Ficus	A fine handsome tree, found occasionally near water-courses.
Dántul	Ditto		

The Rate of Growth of Sal.

Extract from pp. 35, 36 *of the "Manual of Indian Timbers."*

THE wood of the Sál tree has concentric rings, which we at present assume to correspond to one year's growth. There are a few cases on record in which the wood of young trees (up to 15 years) has been found to have a number of rings corresponding to the age of the tree. But sufficient proof to support the assumption has not yet been collected. Assuming, however, that the concentric rings are annual, the following information is available regarding the rate of growth of Sál:—

In 1873, Mr. Fisher examined 40 Sál trees in the Pantan Reserve, Kamrúp district, Assam: 5 trees of 6 feet in girth had, on an average, 10 rings per inch of radius; 20 trees of 4 feet 6 inches girth had an average of 9·7 rings per inch; and 15 trees of 3 feet girth had 11 rings per inch. The rings were counted on lengths of radius, from the centre, of 2·86, 5·73, 8·6 and 11·5 inches respectively, corresponding to a girth of wood only of 18, 36, 54 and 72 inches.

In 1874 he examined 32 trees in the Balipara Reserve, Darrang district, Assam: 10 trees of 1 foot 6 inches girth gave an average of 38 rings, or 13 rings per inch of radius; 10 trees of 3 feet girth gave 61 rings, or 10·6 rings per inch of radius; 10 trees of 4 feet 6 inches girth gave 92 rings, or 10·7 rings per inch; 1 tree of 5 feet 7 inches girth gave 110 rings, or 10·3 rings per inch; and 1 tree of 6 feet girth gave 122 rings, or 10·6 rings per inch of radius.

In 1875 he examined 20 trees in the Sidli forests, Goálpara district, Assam: 3 trees of 4 feet 6 inches girth gave an average of 89 rings, or 10·3 rings per inch of radius; and 17 trees of 3 feet girth gave 50 rings, or 8·8 rings per inch of radius. The rings were counted in the same manner as in 1873.

In 1876 he examined 11 trees in the same forests: 4 trees of 4 feet 6 inches girth gave 76 rings, or 8·8 rings per inch of radius; 7 trees of 3 feet girth gave 51 rings, or 8·8 rings per inch.

In 1877 he examined 17 trees in the same forests: 1 tree 6 feet in girth gave 103 rings, or 9 rings per inch of radius;

1 tree 4 feet 6 inches in girth gave 96 rings, or 11 rings per inch of radius; 13 trees of 3 feet in girth gave 51·5 rings, or 8·9 rings per inch of radius; and 2 trees of 1 foot 6 inches girth gave 26 rings, or 9·1 rings, per inch.

The rings were counted in the same manner in each case. The result of the detailed counting of the rings was as follows:—

Locality.	Number of trees.	Rings counted on a length of radius from centre, corresponding to a girth (wood only) of			
		18″	36″	54″	72″
Pantan (on the hill)	22	30	56	82	115
„ (in the plains)	18	32	65	96	126
Balipara	32	38	61	92	116
Sidli, 1875	20	28	52	89	...
„ 1876	11	26	51	76	...
„ 1877	17	26	51	72	90
	120	30	56	83	112

On an average the number of rings per inch of radius is 10, and it will be noticed that the annual increments are exceedingly uniform. A tree grows:—

up to 18 inches girth (wood only) in 30 years.
from 18 to 36 „ „ „ in 26 „
„ 36 to 54 „ „ „ in 27 „
„ 54 to 72 „ „ „ in 29 „

In the Oudh forests a different result has been obtained. When the first proposals were made in 1863 to regulate the working of the forests of the Kheri division, the following was assumed as the mean rate of growth:—

Girth 18 inches, age 15 years.
„ 54 „ „ 50 „
„ 72 „ „ 80 „

Subsequent data seeming to indicate a somewhat slower rate, it was estimated in 1868, in order to settle the number of trees to be cut over in 1868 and 1869, that a girth of 54 inches would be attained in 65 years, and a girth of 72 inches in 95 years.

In September 1869, Mr. Forrest examined 50 logs cut in the Newal Khar sub-division of the Kheri forests; these logs had a mean girth of 5 feet 3 inches, and gave on an average 4·79 rings per inch of radius. Again in 1877 a Sál tree, about 16 or 17 years old, was examined by Captain Wood, and at 1 foot from the base, where the girth was 1 foot 10 inches, it was found that an inch of radius contained 4·80 rings. Thus, supposing we take 5 rings to the inch as indicating the average rate of growth, the trees examined in Oudh would have attained a girth of 6 feet in 57 years, which, it will be seen, is about one-half the time which the trees examined by Mr. Fisher in the Dúars required to attain the same size.

In the Central Provinces the counting of rings has given a mean between Bengal and Oudh. In 1867, Captain Douglas examined 13 stumps in the Bijeragogarh forests; their mean girth at 17 inches from the ground was 5 feet 3 inches, and the average number of rings per inch of radius was 6·5. In 1874, Mr. Fernandez examined a single stump in the same forests, and 7·2 rings were counted per inch of radius. The mean of the results of these countings is 6·85 rings per inch, which would place the age of a tree 6 feet in girth at 78 years. Subsequent observations in the Banjar Valley forest, Mandla district, give a mean of 5 to 8 rings per inch, and tend to confirm this rate of growth.

The following cultivated trees of known age were measured by Mr. Brandis in 1863:

Saharanpur, and Eastern Jumna Canal 13 years, girth 27 inches (average of 33 trees).

Ditto ditto 30 years, girth 54½ inches.

Ditto ditto 35 years, girth 79½ inches.

Calcutta 25 years, girth 69 inches (one tree).

NOTE.—We have printed this as a continuation of the Memo. on Teak, by Dr. Brandis, published in our last number; and in the hope that our readers will oblige us with any further data that they may possess.—*Editor.*

The Eucalyptus and its industrial application.

The Indian reader may almost be weary of papers on *Eucalyptus*. We have had many; some of them good, some of them indifferent, some of them exaggerated and incredible; nevertheless the subject is one of real importance, so that no really valuable contribution to its literature ought to be overlooked. And the paper which follows is an abstract of a paper written by M. Felix Martin, a French engineer, in the *Annales des Ponts et Chaussées* for October 1877, and is certainly an important contribution to our knowledge.

It contains so much that is of little use in India that I determined to present an abstract rather than a complete translation.

The difficulty in France is to find a species robust enough to stand cold. With us the want is a species that will stand heat and drought. And the difficulty is to get *accurately*-named species.

It is now perfectly well known that while *E. globulus* succeeds in the middle ranges (as regards elevation) of our Himalaya, it will not grow in the plains. It is also known that *E. resinifera* grows freely in the plains as a rule.

What other species really succeed is still doubtful.

Hence the extreme importance of very carefully keeping the *names* of the species.

It is unfortunately too common to read in reports of District and Canal Arboriculture, that "the *Eucalyptus* sown this year succeeded," and so forth. All the while it is not said which of the 160 species is meant! Should any one kind really show good growth, we have no means of identifying it for further cultivation, and can only wait till a specimen flowers, when it can with certainty be identified.

In this way *E. tereticornis* has been identified as succeeding well at Abbottabad, and no doubt at other places, not actually in the hills, but still raised above the plains and the great heat which they have to bear.

B. H. B.-P.

Although the *Eucalyptus* has been cultivated in Algeria on the large scale with complete success, its cultivation in France

has hardly extended beyond plantations for ornament. Numerous memoirs have been published with the object of attracting the attention of agriculturists and foresters, but as yet no one has thought seriously of making the attempt to derive the profit which the growth of this species on the large scale would secure.* It is, indeed, now more than fifteen years that the species was first planted on the Mediterranean littoral, still the stage of experiment has not been accomplished, and it is now time to go further, at least in giving those experiments a wider scope. M. Martin has already made a considerable number of plantations in Provence, and is thus able to offer the results of his experience, especially in its bearing on the utility of the species to the engineer.

Until lately the attempts in France were limited to the introduction of the one species, *E. globulus*, but this species does not quite present the necessary hardy qualities. This again has given rise to the idea that *Eucalyptus* culture must always remain a speciality of Algeria, of Corsica, and of that part of the littoral which corresponds to the region of the orange tree. In that case the subject would have only a limited interest.

We must, however, take into account the resources which a process of acclimatization has at command, and also remember that some of the species are less sensitive to cold.†

The term 'acclimatization' has been criticized on the ground that it is not possible so to vary the natural qualities of a species, as to make it take kindly to a climate different to that in which it grows naturally.

It is true, indeed, that we cannot modify the essential nature of a vegetable species, fixed in the soil and exposed passively to the effects of the weather, in the same manner as we can that of animals by judicious selection and breeding between individuals of exceptional hardiness whose qualities may thus be developed and become hereditary. On the other hand, it is a fact of experience that the continued action of a lower temperature, rendering less rapid the move-

* M. Martin adds that the English—a practical people—have called the tree, "The Diamond of the Forest."

† With us, of course, the problem is to get species, in themselves valuable, which are not sensitive to *heat*.—B. P.

ment of the sap and retarding the vegetative power at critical seasons, may in time render the tissues better able to resist cold. So that plants, if they cannot exactly be *acclimatized*, may at least be *naturalized*. This process may also be aided in the way of natural selection, by the creation of local varieties from successive sowings. Plants grown from the seed of *E. globulus* originally imported from Africa and established at Mentone and Nice, have at Marseilles resisted a cold of —6° centigrade (= 23° F.) These were hardier than plants grown directly from Australian seed which could hardly bear a temperature of —4°. The *Eucalyptus* has certainly acquired the stamp of a naturalized tree in fulfilling the condition that it can spontaneously reproduce itself, by successive seedling growths.

But the genus *Eucalyptus* contains more than 160 species, of which about two-thirds have been tried either in Algeria or in Provence, and within such wide limits as can obtain species which will resist a cold of —10° and even —12°.

Engineers have special opportunities for encouraging the introduction of these species and making them generally known by using them for railway and road-side avenues, and plantations to which they are exceptionally well adapted.

When it is recollected that in France there is a demand for about 4 millions of sleepers annually, and that the demand for wood far exceeds the supply, it cannot be doubted that the acquisition of a species which exceeds in rapidity of growth any indigenous tree, is in itself an advantage almost incalculable.

The *Eucalyptus globulus* was first noticed in 1792, by the botanist Labillardière; he called it *globulus*, from the form of the seed capsules. It was not till 1854, M. Ramel, a Frenchman travelling in Australia, procured some seed, which was sown at Paris in the spring, and had reached a height of about 12 feet in the same year. In 1861 the species was introduced at Algiers, now it may be counted by millions, and other species also were cultivated.

Even in France, a good deal of progress has been made. The whole region between Cannes and Monaco is full of *Eucalyptus*, among the olives, and the *Pinaster* pines. It resists well the violent winds of those localities.

The *Eucalyptus* belongs to the *Myrtaceæ:* all the species have persistent leaves and are more or less odoriferous. They possess a remarkable faculty of absorption. A branch of *Eucalyptus,* freshly cut and weighing 800 grammes and plunged in a vessel containing 48 litres of water, was weighed in the evening and found to be 825 *grammes,* having absorbed in 10 hours, 2·392 grammes (about 32 grains) of water, after allowing for the normal evaporation from the vessel.*

The tree grows naturally in the valleys and moist slopes of wooded mountains from the Gulf of Apollo Bay to beyond Cape Wilson, and thence in occasional groups as far as the Buffalo Range. According to Labillardière it reaches to the colder elevations of the southern parts of Tasmania. Change of climate does not appear to diminish its natural rapidity of growth. In the garden of Hamma, near Algiers, M. HARDI has seen plants attain 18 feet in one season. Both in Algeria and in Provence there are specimens of 35 metres (about 120 feet) high, and there is nothing to lead us to doubt that they may attain to the height of 100 metres (330 feet) observed in some cases in Australia.

It is not surprising that with such marvellous rapidity of growth as a fact, a certain amount of exaggeration has crept into popular accounts. But the following are actual measurements: —

LOCALITY.	Known age.		Height.	Circumference at 1 metre from the ground.
	Yrs.	Months.	Metres.	Metres.
Nice Railway Station† ...	12	10	19·50	1·42
Ditto	11	2	14·00	1·20
On the line from Marseilles to Vintimille near Vence-Gagnes‡...	8	0	8·0	0·50
Level Crossing of the Var ...	7	9	11·0	0·63
Ditto of La Roya near Vintimille..	4	10	8·50	0·37
Railway Station of St. Raphael ...	3	11	6·50	0·30
Slope of the cutting on line to Fréjus	3	11	7·0	0·33

* In the original it is 2·392 with *k.* for "kilo." This must be a mistake.—B. P.

† Both species have been lopped three times, otherwise they would have reached 30 metres.

‡ All the plants were from 40 to 50 millimetres (2 to 2½ inches) high when planted out, and this corresponds to an age of 10 months which is added under the head of total age.

A tree in a garden at St. Raphael, planted in well-worked and manured siliceous soil, *i.e.*, grown with garden cultivation, attained in two years nine months a height of 8·50 metres.

Unfortunately the introduction of the other species of *Eucalyptus* has been too recent to make it possible to give data for comparison of their growth with that of the blue gum. This rapidity of growth is strangely united with hardness in the wood. This hardness increases sensibly with exposure to the air, and is supposed to be, to some extent, accounted for by the coagulation of gum-resins in the woody tissue. These substances are contained in special cells distributed through the wood; they are exceedingly abundant in some species.

It is not, however, to be supposed that hard and strong timber is yielded by any but *mature* trees.

Time must be given for the central concentric layers to lose their porosity by the force of the pressure caused by the growth of the outer layers; and M. MARTIN would put fifteen years as the least age at which such a result could be expected. Experiments made with acclimatized specimens, which of necessity have not reached this age, of course give rise to mistakes and to disappointment.

In Australia excellent building timber, masts for shipping, and sleepers for railways are furnished by this species; but there, trees can be brought from the forest, which for a hundred years and more have been hardening their timber.

It is said that the blue gum will not grow in the company of other trees. This appears to be true. M. CORDIER noticed that when he filled up blanks in a plantation of Conifers with *Eucalyptus* (the plants in the group being 6 feet apart and between 5 and 6 feet high) the Eucalyptus grew, but with greater difficulty than elsewhere.

M. LAMBERT observed that the *Eucalyptus* roots seek a soil which is light at the surface, and that the roots of Conifers being more accustomed to strike downwards did not interfere with the gum roots to the same extent as other shrubs or plants with superficial roots would.

To this perhaps is due the fact that a forest of blue

gum has no undergrowth. It is not due to the fact that the tree only gives a very slight shade. This quality is not without its use, as herbaceous plants only can come up under a cover of gum tree, and so forest pasturage may be obtained without the risk of fire, which always exists where there is a growth of brushwood.

It was also supposed for a long time that the blue gum required siliceous soil, and would not grow on calcareous. It was compared to the Cork-oak, which exhibits such an aversion to the latter that the growth abruptly ceases on reaching it, and thus marks clearly the geological change. But this comparison is by no means true; the blue gum prospers on both soils. All that is wanted is a light and permeable soil; even sand is not unfavorable. The species might possibly be used for planting on the 'dunes.'*

Opinions differ as to the best method of treating the species in plantations—some desiring to attain greater hardiness by letting the plants do without much culture from the very first; either sow the seed *in situ*, or at least put out the plants, where they are destined to remain, while mere seedlings. Others again object to this method, and never plant out the gum tree till it has a completely-formed woody stem.

It would seem, on the whole, that the former plan is better where the soil is good and the conditions of climate not extreme, and the latter where there is a poor soil and an extreme climate.

In Algeria, the sowings are made in September and October; in France, in March and April.

The blue gum in its first youth has a quadrangular stem, which becomes cylindrical as the tree grows up.†

It would seem that the planting out should not be made before the stem commences to grow round, for the younger stems are much more sensitive to cold.

Transplanting is best done in France in April, when the

* We have not found that *E. resinifera* exhibits a dislike to growing with other trees which it soon out-tops. Both this species and others we believe to be *E. rostrata* and *E. marginata*, have tap, or descending roots for some 16 or 17 feet at least.

† The curious change of leaf is also familiar to many readers. The young plants has opposite and sessile leaves, after which they change to *alternate*, with *long leaf-stalks*, and of a different *(falcate)* shape.

vegetation is still retarded owing to the low temperature, but when there is no danger from frost.

In hot dry climates, like the north of Africa, August seems a good month; then the sap is in repose at the close of the long drought of summer more completely than it is in Europe in winter. It profits next by the comparative coolness of September and by the rains of the autumn, while the winter is not cold enough to stop the growth. This season seems very much to resemble the spring of Australia itself.

The *Eucalyptus*, it has been well established, cannot be reproduced by cuttings (*boutures*), nor by layers, and it does not send up root-suckers.

It seems to improve in facility of bearing removal, &c., as it gets acclimatized. It is said that in Portugal, where *E. globulus* is extensively grown, young plants are taken up and moved without earth about their roots, and that for considerable distances, and in a very hot summer.

The species coppices from the stem with great vigor. Some three-year old plants, about 20 feet high, planted along one of the public roads in France in 1866, were broken by a storm of the "mistral" (north-west) wind. They were cut down to the ground, and next year showed a perfect crown of shoots more than 6 feet long.

This valuable property of reproduction is of great *value* in countries where forest fires are feared. Even if burned, the tree would quickly recover by coppicing. It is not, however, known up to what age the species retain this power.*

M. MARTIN has next a series of remarks on the *value* of *Eucalyptus* plantations, which are not applicable in India.

But the following may be given for comparison :—

One hectare (2½ acres) is supposed to be planted or sown; the trees being 1·80 metres (about 5 feet) apart, giving 3,025 trees to begin with :—

* M. Martin recommends *E. globulus* for planting along the edges of fire lines, and thinks it would oppose especially the action of burning fir cones, which are always so much dreaded in spreading a fire among conifers. He does not, however, give credit to any special non-inflammability of the species; and I am rather inclined to doubt the utility of the species in this respect. The resinous leaves are very inflammable.—B. P.

	Francs.
1*st.*—Thinning at three years old 1,210 stems, worth ... ... (leaves trees at 3·60m. apart, or double original distance.)	1,210
2*nd.*—Thinning at six years old 514 stems, worth (leaves trees at 7·20m. apart.)	2,570
3*rd.*—Thinning at nine years 231 stems, worth (leaving 231 trees at 14 metres apart,) valued at	6,930
Total value in nine years ...	17,640

Another valuation beginning with 1,000 trees to the hectare gives :—

	Francs.
1*st.*—Thinning at five years 500, worth ...	600
2*nd.*—Ditto at ten years 250, worth ...	1,313
3*rd.*—Ditto at fifteen years 125, worth ...	1,473
4*th.*—Ditto at twenty years 60, worth ...	1,521
5*th.*—Ditto at twenty-six years 60, worth ...	3,195
Total ...	8,102

The bark is shed like that of the plane-tree, and is very valuable from the large quantity of tannin which it contains. Analysis shows 12 to 15 per cent., which is nearly double the yield of the bark of *Q. Ilex*, which sells at 14 francs for 100 kilogrammes.

The leaves and twigs of the blue gum yield on distillation an essence which is an excellent solvent for copal, camphor, mastic, &c. These essential oils also burn with a white flame without smell or smoke. They have begun to be used in perfumery also.

An infusion made by treating the leaves with alcohol is said to yield a liquor which may supplant the deleterious 'absinthe' so much in vogue. Its medicinal value is also great. In Algeria many fever patients have given up quinine in favor of the decoction of *Eucalyptus*.

M. MARTIN assures us that the therapeutic value of the infusion has been thoroughly tested in France, and alludes to a

work by Dr. Gimbert (Paris, 1875) on the subject, quoting an observed case of cure of a chronic malarious fever acquired on the banks of the Danube. Quinine had been continually taken without effect, and the fever was at last treated with doses amounting to 20 drops of the alcoholic infusion daily.

The leaves being thus valuable, the loppings and prunings on the railway from Marseilles to Vintimille, sell for 25 to 30 francs for 100 kilog.

The value of acclimatized seed cannot be overrated; it produces far more useful plants than freshly imported seed. In order to be fully ripe the seed has to remain on the tree for two years, counting from the date of flowering.

M. MARTIN has sold to the Italian Government seed grown between Nice and Mentone, at a price of 300 francs per kilog. The more general cultivation will of course lower the price, but this is only to be desired. Every part of this tree is, therefore, of value.

M. MARTIN then turns to the uses which an engineer will put the *Eucalyptus* to, on the various roads and other works he wishes to plant. For roads and the slopes of embankments and cuttings the species is to be highly recommended, as the leaves are persistent, and thus superior to the plane, for instance, the leaves of which fall early do not easily disintegrate and choke small drain pipes, &c. The facility of growth by coppice renders it valuable for planting on embankments which have to be *consolidated*. Here the trees are cut back so as to have a mass of shoots.

Eight thousand blue gums have been planted between Marseilles and Vintimille, along the railways. In Algeria this practice has been adopted universally, and every railway may be dated by noting the age of the trees.

A section is next devoted to the value of the blue gum in rendering healthy swamps and malarious localities.

The author believes this to have been definitely established. Certainly several localities in Algeria afford very striking instance on the subject, and recent experiences in France are still more remarkable.

It is, however, little use discussing the subject in detail in

India, because it is quite certain that the blue gum will not grow at all in the plains of Northern India ; and in the middle slopes of the Himalaya, where it flourishes, there is comparatively little of such work to be done.

It is said that the disinfecting and health-giving effects of *Eucalyptus* are not confined to the species *globulus*, but to *rostrata*, *marginata*, *resinifera* and *obliqua*.

It is unfortunate that of these *resinifera* alone is a certain success in the plains. We have recently had *rostrata* seed, and it is now hoped that we may be really sure of the species. We have succeeded remarkably well with trees *called obliqua*, but have no certainty that the species is really this.

We have still, however, to ascertain whether some species will not take readily, and without excessive care and cultivation to the plains. And the difficulty has been, that neither has the name of the species been preserved, nor, it must be confessed, has the nomenclature of seed received from Australia been uniform or reliable. We are only now beginning to get *correct names* for the trees, as one after the other succeeds and produces flowers or fruit which can be sent to Kew for identification.

The species vary in size from a shrub to a giant tree ; they occur in definite geographical and climatic distribution, and it is perfectly certain that some species which will flourish in the higher hills or to the centre and east of the Himalaya, will not bear the climate of the more westerly hills, on the same range, at the same elevation : that some species will suit our sub-montane and intra-montane valleys (*e.g.*, *E. tereticornis* in Abbotabad), while others will flourish in the plains.

The ascertainment of *species* accurately is the present pressing need of Indian *Eucalyptus* experiments.

As regards the planting of dunes and littoral sands, the genus is partial to well-divided and siliceous soils ; but the blue gum is sensitive to sea-air, and can, therefore, only be employed at a suitable distance inland.

A species called "black butt" (*E. persicifolia*) answers perfectly in resisting the sea-air. It has a red fine-grained wood. This is a species found in Gippsland.

As regards the uses of *Eucalyptus* timber, M. Martin has already given a useful caution about expecting much from trees which, however surprising the dimensions attained in a few years, cannot be expected to have had time to harden and consolidate their timber.

Sleepers of trees of 8 and 10 years old, cut at Antibes in the garden of M. Thuret, were put down on the Marseilles Railway in 1872, and gave results inferior to birch.

At Algiers, indeed, M. Trottier exhibited in 1876 telegraph posts, which had been in use for three years, but they were impregnated (*injecté*—what with is not stated). M. Martin says that we have made in India a very interesting experiment, and have succeeded in doing away with the danger which arises to sleepers, beams of bridges, &c., from white ants, by employing the "Járra" or Australian Mahogany (*E. marginata*) as sleepers. I rather think that an experiment *was* tried; and, though the white ants did not attack the sleepers, still the wood split, and otherwise failed to satisfy the authorities. We have heard no more for some years of the import of *Eucalyptus* sleepers.

E. marginata has only very recently been introduced into Algeria, and tried in France.

The value of some of the species in resisting the action of water, and of the *teredo*, &c., is well known.

The size of timber obtained is quite in keeping with its adaptation to ship-building and other works requiring timber of large dimensions.

In 1851, M. Raveret Watel states there was a plank sent to London not less than 47 metres (about 154 feet), 3·50 metres (nearly 12 feet) broad, and 8 centimetres (nearly 4 inches) thick.

A plank of 51 metres (nearly 170 feet) had been prepared at Hobart Town for the Exposition of 1855, but no ship could be found able to take it in. Instead of this a specimen was sent, consisting of a section of another tree. This section was over 3 feet in diameter (more than 10 feet girth) when cut at a length of nearly 200 feet above the root! The whole of this tree, which yielded a perfectly fabulous number of

planks, small beams, and other pieces of all sorts and sizes, realized in all £245-12, or over 2,000 rupees for the one tree!

The paper concludes with a chapter on species most suited for introduction into France.

In Algeria, the *E. globulus* succeeds in a great variety of climate. On the coast, the air is temperate and moist; in the interior, dry and hot. At Constantine, the ancient capital of Numidia, on a plateau of 640 metres elevation, the heat of the vertical sun is great, nevertheless there is both rain and snow.

The mean temperature is 17° (centigrade=62° F.); various other places show temperatures of 16°, 20° and 12° (60°, 68° 53° F.) In all these climates *E. globulus* succeeds, but it will not stand (*e.g.*, at Laghouat in Algeria) the sirocco winds.

The species *E. Gunii*, his failed in France.

E. coriacea is a temperate species growing up to 5,000 feet in Tasmania.

E. punctata is noted for the elasticity of its wood.

E. colossea (diversicolor) has succeeded wonderfully in Algiers, and seems to be unusually handy.

E. robusta, called "swamp mahogany," is not successful.

E. calophylla has *large, shade-giving leaves*, and is specially recommended; it comes from Western Australia.

E. coccifera has been noted as particularly well, resisting severe cold and violent winds.

The 'Argan' Tree of Marocco (*Argania Sideroxylon.*)

This large, gregarious tree, peculiar to Marocco, has only lately been brought to notice. In their "Journal of a tour in Marocco and the great Atlas," Sir Joseph Hooker and Dr. Ball thus describe it :—

"The Argan tree is in many respects the most remarkable plant of South Marocco, and it attracts the more attention as it is the only tree that commonly attains a large size, and forms a conspicuous feature of the landscape in the low country near the coast. In structure and propertie it is snearly allied

to the tropical genus *Sideroxylon* (Iron-wood), but there is enough of general resemblance, both in its mode of growth and its economic uses to the familiar olive tree of the Mediterranean region to make it the local representative of that plant. Its home is the sub-littoral zone of South-Western Marocco, where it is common between the rivers Tensift and Sous. A few scattered trees only are said to be found north of the Tensift; but it seems to be not unfrequent in the hilly district between the Sous and the river Oued Noun, making the total length of its area about 200 miles. Extending from near the coast for a distance of thirty or forty miles inland, it is absolutely unknown elsewhere in the world. The trunk always divides at a height of eight or ten feet from the ground, and sends out numerous spreading nearly horizontal branches. The growth is apparently very slow, and the trees that attain a girth of twelve or fifteen feet are probably of great antiquity. The minor branches and young shoots are beset with stiff thick spines, and the leaves are like those of the olive in shape, but of a fuller green, somewhat paler on the under side. Unlike the olive, the wood is of extreme hardness, and seemingly indestructible by insects, as we saw no example of a hollow trunk. The fruit, much like a large olive in appearance, but varying much in size and shape, is greedily devoured by goats, sheep, camels and cows, but refused by horses and mules; its hard kernel furnishes the oil which replaces that of the olive in the cookery of South Marocco, and is so unpleasant to the unaccustomed palate of Europeans."

Consul Drummond Hay, writing from Mogador, on the 28th February 1878, mentions it in his report on the Trade and Commerce of Mogador for 1877, in the following extract, to which is added the correspondence between him and Dr. G. Birdwood on the subject of the 'Argan' tree and the possibility of its introduction into India:—

Extract from Consul Drummond Hay's Report, dated February 28th, 1878.

Considerable damage was done to the crops of 1877 by the locusts, whose appearance in this part of the country was mentioned in my report for 1876; but, as their devastating flight

was limited only to a certain line of country, many provinces escaped the scourge. The prospects for the harvest of 1878 are at present very unsatisfactory.

Since the first rains in September, only three inches of rain have fallen in Mogador, and, it is reported, still less in Soos and the country lying between this port and Marocco. Cattle in the interior are starving for want of grass, and can be bought in the market for the value of their skins. In the neighbouring provinces of Haha and Shiedma the drought will be less felt, as they are thickly wooded, and the forests of Argan trees above all afford nourishment, both for the natives and their flocks, in times of scarcity.

This remarkable tree grows only in those provinces and Soos, and is utilized in the following ways :—In the first place, the peasants extract an oil from the nut, which is useful both for burning and cooking purposes. When the nuts ripen and fall off the trees, they are collected by the natives, who are aided in the harvest by their goats. These animals swallow the fruit for the rind, but, being unable to digest the nut, they throw it up again, and it is then added by their owners to the store for making the oil.

For their private consumption, the peasants rarely make a large quantity of oil at a time, but crack open a few handfuls of nuts with a stone; and, after toasting the kernels in an earthenware dish, grind them into flour. The oil is extracted by adding water in small quantities to the flour, which is stirred in a bowl. As the oil is being formed by this process, the flour hardens into a cake, which is finally squeezed, leaving the oil perfectly clear and fit for use. This kind of oil cakes then serves as an excellent food for cattle, as also the dry rind of the nut, which is generally given to them with the cake, forming together their principal and most nutritious food during the year, and proving invaluable to the natives in time of drought, for the Argan tree is very hardy, and a dry year has little, if any, effect upon it.

Even the empty husk of the nut, when broken, is not thrown away by the peasant, but used as fuel. The best charcoal is made from the Argan tree, and the dry timber

is excellent firewood. The goats feed also upon the leaves of the tree, and when browsing in the Argan Forest may be seen climbing amongst the trees, plucking and nibbling the nuts and leaves.

Memorandum by Dr. G. Birdwood, C.S.I., dated August 30th, 1878.

I had already made enquiries about the Argan tree, and have learned from Professor T. Dyer that it is the *Argania Sideroxylon* of botanists, one of the *Sapotaceæ*, an order to which many well-known Indian trees, both naturalized and indigenous, belong.

The indigenous species in Bombay are *Chrysophyllum Roxburghii*, "tursiphul;" *Sapota tomentosa*, "Koombul;" *Isonandra Candolleana*, a tree of the same genus as the Guttapercha tree; *Bassia latifolia*, the celebrated Mowah, from the flowers of which Mowah spirit is distilled, and from the seeds of which a large quantity of oil is obtained, used for making soap in the Kaira Zillah, and the wood of which is used for the naves of wheels; *Mimusops Elengi*, "Buckool;" and *Mimusops hexandra*, "Kurnee," the tough close-grained wood of which is used for making sugar mills.

The introduced species are—*Chrysophyllum pomiforme*, from Jamaica; *Mocarphus edulis* from Otaheite; *Kauki* from the Moluccas; and *Achras Sapota*, the Sapota plum of South America, which has become thoroughly naturalised in Western India, and yields a fine dessert fruit, the size and shape of a guinea, covered with a rich brown rough rind, very sweet to the taste, and containing two or three large smooth chestnut-coloured seeds yielding oil.

There is every likelihood, therefore, of the Argan tree succeeding in India. In what localities it would succeed best it would be difficult to say beforehand with any certainty. Marocco consists of the southern slopes of the Atlas range, which stretches in a curve from Cape Gher on the Atlantic to Cape Deir, opposite to Gibraltar, and falls from an elevation of 16,000 feet to the low lands in a succession of terraces exposed to the full influence of the north-west wind, laden with the

moisture it has gathered for more than a thousand leagues in its way across the North Atlantic Ocean. The natural heat of the country lying so near the Tropic of Cancer is, therefore, tempered both by the rain-clouds, which hang over it from October to February, and during the spring and summer months by the south wind which comes over the snow, which lies perpetually on the summits of the minor range of the Atlas mountains, producing one of the most agreeable and fruitful climates in the world. The littoral vegetation is that of the Mediterranean generally. The olive, laurel, citron, almond and fig, and the myrtle, cyprus, oleander, white poplar and aloe, grow everywhere; while the minor uplands (slopes and valleys) are covered with dense forests of tropical trees. Taking these physical facts into consideration, the cosmopolitan character of the order, and the fact that innumerable African plants, both Mediterranean and tropical, have become completely naturalized in India, it is probable that the Argan tree also will flourish in India everywhere, but most in sub-Alpine tracts exposed to the sea breeze and an annual rainfall of from 50 to 25 inches.

It would be most useful of course to encourage its growth in districts exposed to draughts.

It will be observed, however, that it is very similar in its economic properties to the Mowah tree and Sapota plum. The Mowah is one of the noblest native forest trees of India, and is plentiful everywhere in Western India, at least in the Concans, on the Ghâts, in Gujerat, and Rajwara, and if more of a tree like the Argan is wanted in India, it would probably be more profitable to encourage the extended cultivation of the indigenous Mowah, than to squander money and time in the attempt, which might after all prove vain, to introduce a new and imperfectly-known exotic.

Extract from a Despatch from R. Drummond Hay, Her Majesty's Consul at Mogador, dated Mogador, 1st November 1878.

The season here for sowing the Argan nut is during the winter months; it does not take longer to sprout than a melon

seed. The tree is quite indigenous to this part of Marocco, growing only in the hilly districts lying south of the River Tensift (near to Suffee), and I am informed that all endeavours to cultivate the tree in any other part of the country have failed. The soil in which the tree thrives is composed chiefly of limestone and sand. It will grow in very rocky and strong ground, but I have noticed that the finest and most fruitful trees are those which grow in cultivated ground.

Samples of the oil-cake and dry rind of the nut upon which cattle are fed might interest persons desirous of cultivating the tree, and I should have no difficulty in procuring and forwarding them if required.

Report by Dr. G. Birdwood, C.S.I., dated 1st December 1878.

I have examined these seeds. They are in prime condition, and if forwarded to India forthwith by the outgoing mail, will arrive at the most favourable time for sowing them, at least in Bombay. They should be sent in the bag in which they have come, laid in a strong deal box. Copies of all the papers relating to them should be sent with them for the guidance of those to whom the rearing of the trees will be entrusted. I would venture also to suggest that they should be addressed to Bombay, from where they would be most conveniently distributed to the rest of India.

Substitutes for Boxwood.

The following extract from the "Asian" will be read with interest. With regard to a substitute for Boxwood, we should be glad to know whether the wood of *Gardenia latifolia*, Aiton, has ever been practically tried for engraving. It is hard, smooth, even and close-grained, and not liable to split; and in case it should be found to succeed, a large supply might be obtained from the Central Provinces, where it grows on the most rocky soil, and has at present little or no value.

S.

"More than half a century ago, Dr. Wallich, then Superintendent of the Calcutta Botanic Gardens, sent home, we believe to the Society of

Arts, specimens of a large assortment of Indian woods, several of which attracted attention, but nothing more came of it. We had not then an organized forest conservancy department. This department, as we learn from the English papers, has recently despatched—not samples—but a consignment of logs of woods, the produce of our Indian forests. These logs are of irregular shape, some of very large size, and varied so far as quality is concerned, for structural or manufacturing purposes. The collection realized fairly good prices at public auction. Some doubt has been expressed whether, though the prices may have been moderately good, as compared with those which prevail for similar other woods, the cost of transit may not be prohibitive. This remark may probably hold good as respects timber from our mountain ranges; but, in these days of cheaper transit and low freight, the produce of the plains may be exported at a sufficiently profitable rate to induce the despatch of another consignment. Among other woods were logs of Box, the produce of the Himalayas. We believe that this Box is almost equal in quality to the produce of the Black Sea forests, but "the difficulty of transit from the mountains to the sea-board appears to be the great obstacle." Could this be overcome, there is apparently nothing to prevent its competing with the produce of other localities; the more so as Boxwood still continues in such great demand, and the price is so high, that engravers and artists have been endeavouring, but hitherto unsuccessfully, to introduce other kinds of wood in its place. Not very long ago it was reported that the Boxwood forests of Mingrelia, in the Caucasian range, had become well nigh exhausted; and that old forests, long abandoned, were being explored in search of trees that might have escaped the notice of former proprietors. We have not recent statistics at hand, but some three years since rather more than 2,000 tons of Boxwood, valued at about £21,000, the produce of the Government forests in the Caucasus, were exported from Poti; but so large a quantity cannot be reckoned on for the future. At the same time 1,300 tons were shipped for England from the south coast of the Caspian Sea. But little Boxwood of any size is to be obtained in England itself, and we are, therefore, necessarily obliged to draw our chief supplies from the abovenamed localities. If, therefore, among our numerous kinds of woods, any one or two could be found which would prove an efficient substitute for Box, a great desideratum would be gained. Among those hitherto brought to notice, some have been found, though close grained, to be too dark coloured, while others, possessing close grain and a lighter color, are liable to split, which is of course an insuperable objection for engraving purposes. We remember seeing some notice of Sandal wood, raised on a rocky soil, having proved to be the nearest approach, among Indian woods, to Boxwood, in working quality, hardness, and durability under pressure. This was proved some time ago at the School of Arts, Madras, where some blocks yielded

upwards of 20,000 impressions without being worn out. Whether this wood was ever sent to England in order to see if it would prove a substitute for Box in respect to quality and price, we have no means of knowing, but would be glad of information thereon."

[There are other trees in India besides *Gardenia latifolia*, which are worth trying, though that wood is perhaps the best. Most of the Rubiaceæ have a closed-grained wood, and the species of *Randia*, *Gardenia*, and *Ixora* especially are worth notice. *Murraya exotica* from the Andamans has been tried, but it warps a good deal; *Homonoya symphyliæfolia* from the Lower Hills of Sikhim, where it is a commom small tree with much fluted stem, is worth trying, as also might be *Tecoma undulata*, the 'Lahura' of the Punjab, and the Indian wild Olive, *Olea ferruginea*. The 'Paser,' *Parrotia Jacquemontiana*, and some of the *Rosaceæ*, such as the Cotoneasters, have also hard close-grained woods, and our readers will probably be able to suggest more which are worth experiment.—Ed.]

Seedlings of Duabanga on old Charcoal Kilns.

While lately going through the Bamunpokri Plantation in the Darjeeling Terai, I was much astonished to find every here and there a small patch of seedlings of the *Duabanga sonneratioides*. This tree, the *Lampattia* of Nepal, *Kochan* of Assam, *Baichua* of Chittagong, and *Myoukgnau* of Burma, belongs to the natural order of Lythrarieæ, and is readily distinguished in the forest by its large, curving, pendulous branches, with opposite, large, sessile leaves and terminal, big, fleshy flowers. But it is only lately that it has at all come into notice as being of any value. In Burma it is very little used, almost never in Chittagong. Mr. Mann, in his Assam List of 1872-73, speaks of it as having an inferior timber, sometimes used for canoes, and occasionally for ordinary domestic purposes, so that in reality it is only in the Darjeeling District that its value is recognized and its timber sought after. In 1874-75 it began first to be in demand for tea boxes. Up to that time planters had drawn their supplies from the large Toon trees of the hills, which they then found beginning

to become rarer and rarer, and only to be discovered in more and more inaccessible spots. Looking about for woods which might easily replace Toon, Lampattia was hit upon, partly at the suggestion of the Forest Officers, partly by the advice of the Nepalese coolies, who well knew the value of the wood in their native forests. And so it was tried, and one by one the old trees, both on private estates and to a certain extent also in the Government forests, whence in the four years ending April 1878, Lampattia trees to the value of Rs. 2,600 were extracted, shared the fate of the Toon, and were found to be getting more and more scarce. There is still, however, plenty of the wood, and as the seedlings come up profusely on the banks of rivers and in cleared spots where the soil has been turned up, there is no fear of the supply getting very short.

But to return to the patches at Bamunpokri: It has been the practice, while clearing dead wood as well as useless, old, badly-shaped and soft-wooded trees from the plantation, to sell to a neighbouring planter all this refuse material. The planter usually carried away to his factory the best pieces for fuel for his engine, and converted the rest into charcoal. Dotted about, therefore, over the plantation are the sites of old charcoal kilns, with, of course, a large quantity of refuse, charcoal dust, and burnt earth, and upon examination it turned out that it was on these sites that the Lampattia seedlings had come up in such profusion. Now, there would be nothing strange in this if the Lampattia were a common tree in the locality, but it is not so. The Bamunpokri Plantation consists of two plateaux, each with a gentle slope towards the south, and connected with each other by a rather steep hill side. The upper plateau is covered with dense high forest of big timber; the lower is the plantation, and was probably, in the days before júm cultivation was known, a Sál forest. The slope between them is dry, with a southern aspect, and grows little beyond a few Sál and a good deal of the Rhododendron-flowered Kachnar. But at the sides of the plateaux run rivers, which meet below, and on the banks of these rivers are forests of large trees of the more moisture-loving kinds, and it is there that the Lampattia is found. Clearly

then, the seed, which is very light and slightly winged, must have been brought by the wind from the river-banks, from a distance of nowhere less than half a mile, and scattered over the lower plateau, germinating only on the old charcoal kilns, the locality where it found its most favourable conditions. It is strange, however, that it should not have germinated elsewhere on the plateau. The soil, rich with the ashes of countless jungle fires, and only recently turned up by the hoe, would, one would have thought, have been very favourable for the germination; but no, it chose out in preference the old charcoal kilns, so that, wherever such are found, one can safely predict a crop of fine strong-growing Lampattia seedlings.

Advantage has been taken of this peculiarity to make nurseries with charcoal kiln earth and attempt to grow Lampattia plantation. The seed has often been sown before with every care, but has only partially succeeded, and it is pleasing to find at last some prospect at success.

The tree grows extremely fast, very straight and strong when young, becoming in a few years' time fit for poles, and probably in about 40 years fit for tea-box scantling. It has, usually, 5 rings per inch of radius, corresponding to 6 feet in girth at the age of 57 years. There is, therefore, no doubt that it should be encouraged, quite as much as the *Pithecolobium Saman*, the *Prosopis* or the Argan tree of Marocco.

The wood is of a light brown colour, streaked with darker brown and yellow; it is rather light and open-grained, but is durable, makes fine planking and does not warp. It is highly prized for canoes, and is now considered by some as good as Toon for making tea-boxes.

J. S. G.

Notes on the occurrence of the Teak Borer Beetle in Assam.

SIMULTANEOUS with the establishment of the experimental Teak plantations at Kulsi, Assam, there appeared an insect which may yet cause considerable damage amongst the young Teak, although up to the present time its attacks have not been

very serious, only a small percentage of the trees having suffered, and many of which recovered partially or entirely.

The first symptom to be observed is the swelling just above the ground, or sometimes a couple of feet up, of the stem which is occasionally of a considerable size.

On close examination, small punctures in the bark may be noticed just beneath the swelling from which the excrements of the larvæ exude.

After a hot day, the young trees have a fading appearance, though not invariably, and the leaves shrivel up. Frequently this symptom is, however, not present, and the young tree remains apparently vigorous until the larvæ have bored their way so far into the stem that the tree is snapped off by the wind. The globular swelling is evidently the result of the efforts of nature to repair the damage, and is sometimes successful, insomuch that the tree continues to live and thrive, though with diminished vigour.

On cutting over the stem and slitting it carefully open so as to bisect it longitudinally, the larva may be discovered a little above the swelling, in the cavity formed by its having eaten away the pith of the tree completely for several inches in an upward direction. The appearance of this coleopterous larva corresponds with that given in Dr. Ratzeburg's "Waldverderber," under the head *Cerambyx*, of which it is evidently a variety; it is yellowish-white, footless, and about 1½ inches in length. It converts the pith of the tree into a kind of fibre as it bores its way up, and it utilizes some of this fibre afterwards in preparing its cocoon.

It appears usually in one and two-year old trees, but has also been found in trees of five and six years' growth. Up to the year 1877 no perfect insect, or beetle, had been discovered, although the presence of the larvæ had been noticed since 1873. In the end of March 1877, however, the Assistant Conservator of Forests, Gauhati Division, collected some sections of stems with the larvæ inside them, and had the satisfaction of finding them eventually transformed into beetles on the 21st of June in the same year, having in the meantime passed through the intermediate stage of the Chrysalis.

These beetles are very similar to the "*Cerambyx Carcharias*" shewn in the colored diagram No. II. of Ratzeburg, only somewhat smaller.

Owing to the fact of the larvæ being found in the young Teak all the year round and the variety of the perfect insect itself, it is believed that the beetle has a biennial development only, which is the case with the *Cerambyx* mentioned by Ratzeburg. The treatment in vogue at the Kulsi Plantation is to coppice all young and badly-attacked poles, and encourage the growth of the strongest shoot from the stool by removing the rest, when they appear. In the case of older and more vigorous trees, which do not appear otherwise sickly or fading, these are left alone, and often recover the effects of the borer's visitation to all appearance at any rate although trees of the globular swelling invariably remain.

A. G. MEIN,
Assistant Conservator of Forests,
Gauhati Division.

KULSI PLANTATION,
23*rd February* 1879.

The function of the Pines and the Larch in the production of Soil.

(*Continued from page* 247.)

The *Pinus Cembro*, the 'Arolle' of the Swiss Alps, is also called 'Auvier' in French, 'Arve' in German, and, though wrongly, for the name of cedar has been given it though no cedar is indigenous in Europe, 'Keder' in Russia. It probably has many other names east of the Ural Mountains. It is a sporadic growing tree, found here and there in clumps at great elevations, and scattered in places everywhere from the Alps of Provence to Kamstchatka. It seems to like the most out-of-the-way and cold corners away from the action of man and his cattle.

In France the Cembro is never found below 2,000 metres in altitude; it is chiefly indigenous to the quiet zone, between 2,000 and 2,200 metres, which also is inhabited by Marmots

It is most often found as scattered trees, here and there in the upper portion of the forests of larch and mountain pine. Under their protecting shade it has grown, and when they have later on disappeared, the 'Arolle' alone at the limit of arborescent vegetation in its turn protects as rear guard the forest whose upper limits are gradually getting lower and lower. It is sometimes found growing gregariously, as in the forest of Ayes, whose very name comes from 'Ayou,' the patois name of the Arolle, and there it is the principal tree in a forest covering 200 to 300 hectares of land. This little forest belongs to the commune of Villars-Saint-Pancrace near Briançon, and is hidden in the depths of a valley, high up in the hills behind the great peaks, and on the promontory formed by the junction of two feeders of the principal stream. It has been much cut about and damaged by the axe and by grazing, and has been to a certain extent invaded by the larch: the largest specimens measuring one metre in diameter, and eight or nine centuries old, are close to the chalets of LaTorre, whither the cattle only go for pasture on the 15th July and remain only five weeks.

The places in Europe where the Cembro is most abundant are in the Engadine and the German Tyrol. It is also found at the head of some valleys in the Carpathians and in Ural and beyond that on the Altai hills, and round the Okhotsk Sea.

The 'Arolle' is a fine tree, often 15 metres in height; it has flexible branches, which bend but do not break under the weight of the thickest snow. Its soft, bright green needles, arranged in fives, give it some resemblance to the Weymouth pine of our gardens, but the leaves of the Cembro are much more abundant and closely set, and its rounded head is often but a mass of foliage where the forked-tailed Capercailzie loves to hide, and whence the sportsman finds it difficult to dislodge him.

The bark of the Cembro, fresh and green when young, and covered with little cells full of turpentine, becomes at last dry and of a reddish grey color. The numerous roots spread around the feet of the old Cembro, stretch themselves far in

fan fashion, half exposed and fixing the soil in the most safe way possible.

The forests of Cembro prefer the fresh soils, and the glades are covered with bilberries and rhododendrons which serve as a home for the Capercailzie, the Chamois and the white Hare.

The Squirrel and the Woodpecker abound, and break open the solid scales of the cones for the sake of the nut within. The inhabitants also collect these fruits, which are sought often as a help to the scanty food of those cold regions. The seed, with a shell harder than that of a filbert, only germinates two years after its fall, and remains thus exposed to every cause of destruction; the young plant remains weak during many years, frail and liable to be trodden down by cattle, so that the reproduction of the forests, when once they have been reduced to a small number of trees, is almost entirely prevented. Here and there under the shelter of a rock, or between the roots of some light-foliaged tree, such as the larch, the last representatives of the species sometimes develop themselves by chance. Were it not for its longevity, we should know it no longer in France, and beyond purely cultural reasons, there is now some interest in preserving our few remaining Cembro pines.

The Larch (*Larix europæa*) is also a tree of northern and cold regions. It forms a genus by itself among the European conifers, and it has, by its non-verticillate ramification and its faculty of giving out numerous twigs, considerable relationship with the broad-leaved trees. Thus, in the fields of the Tyrol, larches may be seen with their branches cut off close to the stem and tall and thin like the Lombardy poplar, covering themselves with new branches along the whole length of the bole; while in some forests this pruning operation gives the village firewood, while the stem is only cut for building, the wood having often become by the process, knotty, misshapen and somewhat decayed.

Like the spruce, the larch forms large forests at the limit of forest vegetation in Northern Russia and in the Alps. It will only grow well in a dry climate and under a clear sky, so that in the Alps it is chiefly found on the Italian side, and in Russia it is chiefly found in the north-east, while the

spruce prefers the north-west with a totally different style of soil and climate. The European larch has several relations in the world, the most important of which is the American larch, better known under the names of Hackmatack or Tamarack. In the French Alps, the larch is found between 1,200 and 2,400 metres, and most common with a fresh northerly or easterly aspect. In some places still, the whole slope of a valley may be seen, covered with larch from the bottom of the valley to the line where all tree vegetation ends; the foliage is developed in spring at the time when the snow disappears from the ground at the foot of the trees, the forest gradually reclothes itself in verdure from the base to the summit, and sometimes it requires a whole month, from the middle of May to the middle of June, for such a forest to recover its full verdure. And then how fresh and tender is that verdure! Under the larches extends a green carpet sown with the varied hues of different flowers, and the foliage of the trees, of the same colour as the grass, covers itself with the red flowers which form later on the cones, while light, pure and gay, enters from every side. Life seems light like the air of the Alps, and there is nothing which can compare with the calm of these elevated regions.

The larch is a slow-growing tree: after eight months of rest growth is awakened for scarcely four; and besides, the summer is usually dry and the heat moderate. Those which add yearly one centimètre in girth are fine trees; but generally about two centuries are requisite for trees to reach 1½ metres in circumference, and then they are only at middle age; later on, the back gets thick, the top dies, but the tree continues to increase in girth. Larches of a metre in diameter are not very rare, but they must be sought for in places well sheltered from the wind. A few years ago, might have been seen, on a promontory separating the Guil from the torrent of Riou-Vert, and belonging to the village of Saint Veran, the highest in the Alps, a little hidden plateau, quite covered with big larches, containing about three hectares, and with trees whose stems had an average diameter of nearly one metre; it was a very pretty sight, but many of the trees

have since disappeared. It is also in the same canton of Aiguilles, formed by the valley of the Queyras, that the most important extent of larch forest in France, comprising 5,000 to 6,000 hectares, is found. That beautiful valley begins at the foot of Monte Viso, opens towards the west, reclosing itself with the exception of a narrow passage before joining that of the Durance. The meadows at the bottom of the valley rise to an altitude of 1,400 metres; the slope with southern aspect is covered with vast pasture grounds, and the opposite slope is covered with forests. These forests belong to the eight Communes of the valley, some of which, such as Molines and Ristolas, have their houses all built of wood provided with large balconies, of an uniform style, but blackened by time and the weather.

The larch rarely reaches a height of 30 to 40 metres; usually it stops at half that size. It has often a slightly curved bole, very conical and branched low down; its form is nevertheless always regular, and the forest is usually of pure larch unaccompanied by any other species of tree. It reproduces itself easily, although slowly, everywhere that pasturage does not prevent it; it even invades fields which have been left fallow and abandoned pasture grounds: but, under the constant action of the flocks which are yearly sent up for the summer to the higher regions, its upper limit is gradually descending lower and lower like that of all the forests of the Alps. In the Pyrenees, on the other hand, the forests of beech and silver fir, grazed over from below, seem gradually to ascend towards the inaccessible regions.

In forests of larch, trees which have been dead for more than a century are frequently found, round which young growth is no longer to be seen, and who are now the last representatives of the forest which has disappeared. In a forest in the valley of the Cervieyrette, which joins that of the Durance below Briançon, above the Côte des Chèvres, was visible, 20 years ago, an enormous larch, short, quite dead, and having even lost all its bark. At 4 or 5 metres from the ground was a thick horizontal branch, and on this dead branch

lived a larch tree already of large size, about 70 years old, and deriving its nourishment from the decomposed wood of the parent tree. Can it still be living ?

Forest Denudation and Famines.

Extract from a Paper entitled 'Irrigation regarded as a preventive of Indian famines, by W. T. Thornton, Esq., C.B., read at the meeting of the Indian Section of the Society of Arts on February 22nd, 1878.

I fear I have already detained this meeting too long, although as many persons present must be aware, I have only lightly skimmed the surface of my subject. If, then, I venture to claim attention for a minute or two more, it will be only in order to show how merely fragmentary my whole discourse has been. It has been almost confined to consideration of the best means of preventing water that might be beneficially diverted to the land from being carried uselessly by rivers to the sea, but no allusion has been made to the at least equal importance of providing beforehand for detention of part of that water on the land, and for preventing it from ever reaching the rivers. Three-quarters of a century ago, immense tracts in Southern India were overspread with jungle, and the slopes of both Eastern and Western Ghâts were almost universally forest clad, but most of the level woodland has since then been cleared for cultivation, and the hills have been stripped of their trees in order to suppy fuel for the railways. Contrary to what might have been expected, there is no evidence to show that the actual rainfall has decreased in consequence, but it is notorious that another and scarcely smaller evil has resulted. Formerly the water showered down from the skies was partially protected from evaporation by sheltering trees; its flow over the surface was mechanically resisted by standing trunks and fallen stumps, and by jungle-grass, mosses, fungi, and decaying leaves; it had time to be absorbed by the upper layer of vegetable mould, and, after this was saturated, to sink into the mineral earth below, and to fill

whatever cavities there might be still lower down, thereby converting them into reservoirs calculated to ensure the permanence of natural springs. What remained proceeded to replenish the tanks it met with on its passage; and not till all this was done did the residue find its way to the rivers, and that at a comparatively tardy pace. Now, however, as a rule, the rivers are in violent flood for about as many days as they used to be for weeks in moderate flood. No sooner is there a copious fall of rain, than a perfect deluge scours the fields, washes off whatever slight dressing of manure or other fertilising elements there may be on the surface, often sweeps away the growing crops, or covers them inches deep with sand, breaches entire chains of tanks, and finally reaches the rivers in torrents, which destroy, or seriously damage, massive railway bridges and still more massy anicuts. Wholly to obviate these gigantic mischiefs might, perhaps, be impossible, except by expedients more mischievous still, for no one would wish to see the corn and rice fields that have taken the place of jungles, replaced in turn by the jungles they have supplanted. Still, art and nature combined might easily, one would think, re-clothe with wood hills which nature once clothed without help from art; there is all over India abundance of waste land on which Government might, with profit to itself, form plantations; and kindly counsel on the part of revenue and other authorities might everywhere persuade village communities to surround their fields with hedge-rows, and to convert district roads into shady avenues. This, however, is a topic on which I cannot now dwell, though I could not altogether forbear from referring to it with the view of suggesting that, however desirable it be to extend irrigation to the utmost, there may, nevertheless, be arrangements of a different kind that may go far towards doing away with the necessity for irrigation.

Rings in Teak Wood: Are they necessarily annual?

In the number for January last of the INDIAN FORESTER was published a Memorandum on the rate of growth of teak by

Dr. Brandis. It was therein stated (see para. 3) that "it is now *established beyond doubt* that the concentric rings * * * * * * * * * * * * * * in the wood of teak correspond each to one year's growth." The italics are mine. Now it is a well-known rule in logic that a single particular fact to the contrary destroys the truth of a universal proposition. If, therefore, I bring forward only a single instance in which the number of rings in a teak tree was in excess of the known age of the tree counted in years, the broad statement quoted from the memorandum in question falls to the ground. But it is not only one such instance that I have observed, but several over and over again, so that it is impossible I can be mistaken. In the hot weather of 1874, I copsed teak over an extensive area in the Punassa Reserve. In December, of the same year, a fire spread over a portion of this area, and killed, or badly injured, some of the coppice shoots that had come up in the preceding rains. Some of these shoots I cut off out of curiosity, intending to keep them as specimens of the vigorous early growth of teak from the stool; many more I cut back to produce a new clump of sound, straight shoots in place of those injured beyond all hope of remedy. To my astonishment I found that about two per cent. of the shoots cut off had each two well-defined rings of wood. I say *well-defined* advisedly, for they clearly were not what have been called spurious rings, which are occasionally observed even in European timber. Here there were shoots, barely six months old, which possessed two rings. I tried to account myself for this contradiction to received opinion, and the experience of such excellent authorities as Dr. Brandis and others. If I could have proved that, as often happens in our forests here, through the ravages of a caterpillar, the first flush of leaves had been destroyed and replaced by a new flush, then in the case of those shoots, in which the interval between the shedding of the old leaves and the appearance of the new was long enough to cause a cessation of circumferential growth, a double ring for that year's growth would be the result. This circumstance, however, could not be established with certainty, since the necessary special preliminary observations were wanting. The following year, 1875, I

had occasion to cut back a number of injured shoots among the re-growth of the coppice cuttings of 1871. Here, again, many shoots contained one ring in excess of the number of years in their age, and the cause of this apparent anomaly was of course less easy to explain for the same reason as before. Since then, I have observed the same anomaly over and over again, and I drew attention to it in some shoots that I sent to Calcutta with other specimens of forest produce intended for the late Paris Exhibition. Mr. Smythies, who collected the data for Dr. Brandis' Memorandum, evidently ignored the remarks I made in the paper accompanying the specimens sent, or unintentionally overlooked them.*

I think I have said enough to establish beyond doubt that two rings of wood may be produced in teak in a single year. The cause still remains to be ascertained, but it must in all probability be referred to an interval of repose, dividing the season of vegetation for the trees so affected into two distinct periods. The production of more than one ring of wood in a single year in many tropical trees and large climbers has been ascribed to this cause by all writers capable of forming an opinion on the subject. And the probability of my position is still further strengthened by observation of a teak shoot, examined last month by Major Doveton and myself, which, although the growth of the south-west monsoon of 1878, has developed a new terminal shoot about a foot long, and has thus all the appearance of a sapling two years old. In this remarkable instance, therefore, there was a cessation of longitudinal as well as circumferential growth, dividing the season of vegetation into two entirely distinct portions.

Before concluding this short note, I ought, for the benefit of those not acquainted with the teak forests of the Central Provinces, or of teak forests in other regions possessing similar conditions of soil and climate, to add a few words in explanation of a remark made *en passant* higher up. It is not uncommon for teak to be attacked over whole tracts after the cessation of the south-west monsoon by a caterpillar, which

* The remarks were overlooked.—Ed.

frequently destroys all the foliage and leaves the trees entirely bare. If this occurs before the end of December, or, provided the soil is moist, even later, the trees soon cover themselves with new foliage, the interval between the fall of the old and the appearance of the new leaves varying, according to circumstances, from a few days to a fortnight. To quote one of many instances, in travelling towards the end of October 1875 from Harda to Jubbulpore, I found the stretch of teak copse on the left bank of the Tawa River as denuded of foliage as if we were in the middle of the hot weather. When I was returning to Harda early in November, the whole forest was clad in bright green as far as the eye could reach.

March 1879. E. E. FERNANDEZ,
Asst.-Consr. of Forests, Central Provinces.

JJ. Official Papers.

Sind Forests.

Office of the Inspector-General of Forests;
Calcutta, the 19th January 1878.

It may be regarded as certain that the Indus Valley Railway must draw a great part of the fuel required for working the line from these forests, and that consequently the demand for wood will increase considerably.

The efforts of the Forest Department, therefore, must now be more than formerly directed to the regeneration of the forests. It seems to me that three measures should be considered, which may tend to be useful in this respect. These measures are :—

I.—To acquire as large an extent of river frontage as possible, and to take possession of all alluvium that forms in front of it, and on no account to permit any of this alluvium to be cultivated. It is well known that these fresh-formed lands cover themselves, where sufficiently high, with a complete crop, be it water-sown or wind-sown, of tamarisk, poplar, and (in Lower Sind) of babool; and, if we could get a sufficient area annually of these new lands, they would regenerate the forest in the most efficient and economical manner. But this involves two conditions—no cattle must be admitted into these kachchas, and no land must be broken up in them for cultivation. The temptation is great to make a good revenue from these rich lands, but then the young growth is lost.

On the understanding that the whole of these new lands, which are at the disposal of Government, are maintained as forest, and carefully protected, the cuttings in the older part of the forest can be considerably increased. And, as a matter of course, whenever the river sets in upon old forest, the land threatened should be cleared early enough. No trees should be allowed to be carried away by erosion; they should be cut

and utilized. This will require special arrangements and great vigilance, for the river often sets in suddenly in a new direction; but the task is not impossible, and the annual reports show that great progress has already been made in this respect. A careful account of all annual acquisitions of fresh-formed land should be kept; they should be numbered and entered as new compartments in the register, and the progress of the young growth on them should be recorded.

The area of young growth annually acquired in this manner will be an important factor in determining the quantity of wood that may be cut annually over and above that threatened to be carried away by the river.

II.—The river frontage at the disposal of Government is not sufficiently extensive to give a sufficient extent of new land in front of it covered with young growth; efforts must, therefore, be made to promote the regeneration of the old forest wherever cuttings have been made. The first step to secure this is to exclude cattle from selected blocks sufficiently long to enable the young growth to come up. Experience has shown that, wherever cattle have been excluded, and the ground was sufficiently moist, an abundant crop of babool and other trees springs up from hand-sown or self-sown seed. The annual revenue from grazing has, from 1857-58 to 1877-68, averaged Rs. 33,000, and during the three years, from 1874-75 to 1876-77, it has averaged Rs. 35,700.

It is not necessary to sacrifice the whole of this revenue, for a portion of the forests may continue to be open to cattle, and pasture being scarce in Sind, it is not unlikely that nearly the same revenue will be obtained from a restricted area; but whether revenue is sacrificed or not, selected blocks must be closed absolutely against cattle, and must remain closed, until the young growth is sufficiently advanced to be beyond the reach of cattle. I say, advisedly, *selected blocks* must be closed, for on dry ground, not moistened by overflow or percolation, the exclusion of cattle would not do much good. It is, however, for consideration whether it will pay to carry water to such lands, and in such cases cultivation would be in its place, as a temporary measure, in order to cover the cost of irrigation. Dr.

Schlich, while in Sind, I believe, initiated a system of raising babool and poplar in lines on fields, which yield their crop during a series of years, being irrigated until the young trees are sufficiently advanced to be left alone. In this manner the area covered with young growth may be considerably increased.

III.—It is obvious that the quantity cut annually in Sind must be regulated by the quantity annually produced; and, broadly speaking, we may say that the quantity of wood cut annually must depend upon *the areas stocked* with young growth of different ages. Each annual report should contain sufficient information to satisfy Government that a sufficient area of land is under young growth, be it self-sown in new lands, or produced on old lands by the keeping out of cattle (and fires, as a matter of course) and by irrigation. These considerations should regulate the quantity of the annual yield. *As regards the localities where cuttings should be* made, it has already been pointed out that loss of forest by erosion must be anticipated by cutting, and this will yield a considerable quantity of material. Otherwise I think that the general rule should be laid down, that no cuttings should be made in localities which are not protected against cattle and fires, and which are not sufficiently moist, naturally or by irrigation, to warrant the expectation that under due protection and proper management a good stock of young growth will spring up. It should be carefully considered whether forest administration in Sind is sufficiently advanced to admit of a strict observance of these principles. There may be outlying pieces of dry land which it may not be found expedient to maintain under forest, and which may be cut, therefore, without regard to reproduction; but, as a rule, cuttings should be made in such places only where there is good ground to expect that young growth will come up on the clearances made, excepting only where the land is threatened by erosion.

The preceding remarks contain nothing new; they are based on the suggestions made in my Report on the Sind Forests

which I had the honour to submit to the Bombay Government in February 1869, on the proposal made by Dr. Schlich while Conservator of the Sind forests in 1871 and 1872, and on the proposals made and progress reported in Mr. Campbell's annual reports.

These last-named reports, indeed, show that considerable progress has already been made in the direction here indicated. It may, in conclusion, be useful to state a few figures which are taken from my report of 1869, and Mr. Campbell's report of 1875-76. These figures will show that, apart from the three measures suggested to promote the regeneration of the forests, it is imperative to increase the area of the Sind forests very largely.

The area of the Sind forests was

In 1869	...	...	317,245 acres.
„ 1876	...	...	352,041 „

During the four years, from 1872-73 to 1875-76, the losses and gains by the action of the river were as follows :—

Gained	...	...	48,005 acres.
Lost	...	...	26,873 „
Excess gain	...	...	21,132 acres.

But, as the Conservator explains, all the new land consists of banks of mud and sand of little present value, while part of the land lost was covered with valuable forest.

Therefore, the whole of the gain of 48,000 acres cannot be classed as young growth: some of it may be carried away before it is raised sufficiently to become stocked; but whatever of it remains, may probably mostly, if duly protected, become covered with young forest.

In addition to this area, whatever that may turn out to be, the Conservator reports that 54,500 acres of old forest are closed against cattle and under treatment to promote reproduction. These operations are of comparatively recent date, a commencement having been made in 1873 with 513 acres; but there seems good reason to hope that, if these operations are steadily continued, a considerable proportion of the forest

area will, in a few years, be stocked with young growth. Cuttings may then, as a rule, be restricted to the areas under treatment and to the areas threatened by erosion. It should, however, be stated at once that the time fixed for closing these areas placed under treatment (5 years) will be found to be much too short to do any real good. But that will easily settle itself afterwards.

The yield of the forests has been as follows, expressed in cubic feet of solid wood :—

	1866-67.	1867-68.	1874-75.	1875-76.
	Cub. ft.	Cub. ft.	Cub. ft.	Cub. ft.
Timber and building wood ...	168,680	156,629	74,209	94,243
Firewood	1,494,860	1,486,849	1,977,680	1,936,750
	1,663,540	1,643,478	2,051,889	2,030,993

As far as these figures go, they indicate that the demand for timber and building wood has diminished, but that for firewood the demand has increased considerably. So far, however, the increase here shown, has not yet been materially affected by the requirements of the Indus Valley line, and it may well be that the demand will double within a few years.

Now, it is quite impossible to say, while the forests are in their present condition, what the yield of the present area of 352,000 acres will be: their yield 10 years ago amounted to 5 cubic feet per acre per annum, and in 1875-76 it was nearly 6 cubic feet. That is as yet a very small yield: but the matter would be different if the material removed were to rise to 35 or 40 lakhs, or to more than 10 cubic feet per acre per annum. It is by no means certain whether such a quantity could, with safety, be taken from the forests in their present condition.

Under these circumstances the only thing to be done is to endeavour considerably to increase the area of the forests. The Conservator reports, in his report for 1874-75, that he had proposed the addition of 30,000 acres in the vicinity of

the line north of Sukkur; this is a move in the right direction, and every effort should be made to increase the area by the addition of large, compact blocks of forest land where wood can advantageously be produced.

It is not here the place to discuss the important question how to stimulate the consumption of timber and building wood from the Sind forests, which, as a matter of course, pays much better than firewood. The cultivation of sissoo and bamboos is a move in the right direction; and it is a matter for consideration whether the production of the poplar, mixed with the tamarisk, should not be encouraged, as the demand for this wood in Sind is likely to be greater than for babool, which is hard and difficult to work.

As regards fuel, attention should be given to the Kundi (*Prosopis spicigera*) which is valued as railway fuel in the Punjab, which is more hardy, and requires less water than either babool, poplar or sissoo, and which reproduces well as coppice wood.

The chief suggestions submitted in these remarks may be summed up as follows:—

Endeavours should be made to increase the area of the forests, particularly with the view of obtaining a longer river frontage.

Efforts must be made to stock as large an area as possible with young growth, both on new lands and by special protection and treatment in the older parts of the forest.

Cuttings should, as a rule, only be made on the specially protected blocks, except where the forest is threatened by erosion.

D. B.

Memorandum on the supply of Railway Sleepers of the Himalayan Pines impregnated in India.

By D. Brandis,

Inspector-General of Forests.

Dated Simla, *the 21st October* 1878.

In June 1877, the Government of India, in the Public Works Department, suggested special consideration of the subject of the supply of indigenous timber for railway purposes, as at that time it was supposed that the war in Europe might possibly interfere with the supply of sleepers for railways in India.

2. The result of the enquiries then made, and of all the information which was previously at the disposal of the Government of India, is that the supply of timber sufficiently durable for railway sleepers in India is not sufficient at present to meet the requirements for construction and renewals, and will not be sufficient until the forests in charge of the Forest Department have grown up, and this will not be for a long series of years.

3. The principal woods which are sufficiently durable for this purpose are *teak*, *sál* and *deodar*. The statements appended to this Note show the number of sleepers furnished to State Railways since 1870 by the Forest Departments in the Punjab, the North-Western and Central Provinces until the 1st April 1878, and in Bengal and Burma until the 1st April 1877. These statements do not exhibit all that has been done in this respect by the Forest Department in these provinces, for much timber sold by them which was afterwards used by the railways was sold in the shape of logs, and not in the shape of sleepers, and is therefore not entered in these returns. Nor do these statements give the cubic contents, for a portion were broad and a portion were narrow-gauge sleepers.

From a detailed statement lately received from the Director of State Railways, Central System, it appears that the following quantities of different kinds of timber were received on the

Rajputana, Sindia, Holkar and Neemuch State Railways up to the 30th September 1877:—

Kinds of Timber.	Number of sleepers.	Cubic feet.
Deodar	1,472,759	4,450,262
Chir (*Pinus longifolia*) (creosoted)	2,000	6,944
Chir (uncreosoted)	11,830	38,558
Kail (*Pinus excelsa*)	2,628	3,503
Creosoted pine from Europe	561,919	948,237
Teak	3,245	3,826
Dhaura (*Lagerströemia parviflora* and *Anogeissus latifolia*)	3,082	9,819
Hardu (*Adina cordifolia*)	2,396	3,594
Anjan (*Hardwickia binata*)	2.167	3,250
Bija sâl (*Pterocarpus Marsupium*)	976	1,464
Other woods	58,813	96,039
Total ...	2,121,815	5,565,496

4. The chief object of these statements is to show the relative importance of the different descriptions of timber; and it will be seen at a glance that of indigenous timbers, *deodar*, *teak* and *sál* have been the chief kinds supplied. There are numerous other durable woods; but some of these are so hard, heavy and difficult to work, that they are not in favour with railways, such as Anjan (*Hardwickia binata*), Babul (*Acacia arabica*), Sundri (*Heritiera littoralis*), Mowah (*Bassia latifolia*) and Iron-wood (*Xylia dolabriformis*). Others are not sufficiently abundant, and are too valuable for the requirements of the local population to be available for railway sleepers. To this class belong Blackwood (*Dalbergia latifolia*), Sissu (*Dalbergia Sissoo*), Bija Sâl (*Pterocarpus Marsupium*), the species of *Artocarpus*, and numerous other kinds.

5. I have no doubt that eventually some woods, which are abundant, though they are not as durable as teak, sál and deodar, will be used to some extent; and that by careful seasoning and cutting them at the right time, their durability can be somewhat increased, but this source cannot be regarded as of great importance. To this class of woods belong, among others, Saj (*Terminalia tomentosa*), Dhaura (*Anogeissus latifolia* and *Lagerströmia parviflora*), and the other species of *Lagerströmia*.

6. Speaking broadly, it must be acknowledged that, in considering the supply of indigenous timber for railway purposes, we must limit our enquiries to teak, sâl and deodar.

Large supplies of teak timber for railway purposes can at present only be expected from Burma, the forests of North Kanara, and to a smaller extent from the forests in the south-eastern districts of the Central Provinces, Bastar and other Native States adjoining them. But the high price which teak commands will always prevent its being used, except locally, on any large scale for railway sleepers. Teak sleepers are, and will doubtless chiefly be, used on railways in Burma, and to a small extent on some of the lines of South and Central India, as well as in Bengal, a short distance inland from Calcutta. But for the great Railway system of Northern India, teak sleepers cannot be thought of.

7. The supply of mature sâl timber in the forests under the control of Government is very limited at present. The sâl forests of Bengal are expected eventually to yield a very large annual outturn, and may, 50 years hence, be found sufficient to supply the requirements of all railways in Lower Bengal; but at present large cuttings are not possible. The forests of the eastern districts of the Central Provinces will furnish sleepers for renewals on the lines within easy reach of Jubbulpore, and perhaps for the line intended to be built eastwards from Nagpur.

8. The sâl forests in the Sub-Himalayan tract of Oudh and the North-West Provinces do not contain mature timber enough to do more than supply local demands, and cannot, for many years to come, be depended upon for large supplies of railway sleepers.

The only extensive sâl forests which can be expected at the present time to furnish large supplies of railway sleepers are those in Nepal; the authorities in charge of these forests are most anxious to develop the export of timber which can be floated down by the numerous feeders of the Sarda, the great Gunduk and the Ganges rivers, and the Railway authorities will do well to utilize this source of supply to the utmost. The supply from this source ought to furnish renewals for a portion of the Oudh and Rohilkhand lines, and for the East Indian

Railway below Allahabad, and sleepers for construction of provincial railways in Lower Bengal.

9. As regards deodar, matters are similar. The quantity of mature timber in the forests, leased and British, under the control of the Forest Department of the Punjab and the North-Western Provinces, is very limited, and has been so much diminished by heavy fellings to supply sleepers for the Rajputana and Punjab lines, that cuttings must, for many years to come, be reduced considerably, and no considerable supply of sleepers can be expected from that source. Small quantities may be obtained from Native States between the Beas and Tons rivers, the forests of which are not leased by Government, but the largest supply must be expected from Kashmir. The deodar forests in that State should be drawn upon largely for the extension of the Northern Punjab State Railway, and they may furnish renewals for the Sind, Punjab and Delhi, and part of the Indus Valley Railways.

10. These are the chief sources of indigenous sleeper-supply. It will be understood that I have purposely limited my remarks to general results, but they can be relied upon for practical purposes. Small supplies of durable sleepers may here and there be obtainable otherwise, but the sources mentioned are the only ones which can be depended upon for large quantities.

11. At the present time, I understand no difficulty is experienced in the supply of sleepers for construction and renewals on the State Railways and guaranteed lines. Both iron and creosoted pine sleepers are obtained in sufficient quantities, and at exceedingly low rates from Europe at the present time.

Thus, with the supply from Europe, and the existing indigenous sleeper-supply, the present requirements of the railways are fairly met. But these sleeper-requirements must increase on account of the contemplated extensions, and the increase of renewals on the older lines. The renewals on the East Indian Railway alone fluctuate between 150,000 and 200,000 broad gauge sleepers annually, and will soon reach 200,000 sleepers a year. It would probably be an advantage to that line if the renewals of the upper portion above Allahabad could be provided from indigenous sources.

12. Even with the present cheap rates and the abundant supply of sleepers from Europe, there must be a portion of the inland districts of North India, for which it would be desirable to have a supply of sleepers on the spot from the Himalayan and sub-Himalayan Forests. I am aware that it is considered desirable, gradually, to substitute iron for wood sleepers throughout India, and that it is hoped that the Bengal Iron Works will be equal to supply a very large proportion of the sleepers that will be required by railways in India. But, whether the iron-sleepers come from England or from Bengal, there must be certain lines in the inland districts of North India for which it would be both convenient and economical to have local sources of sleeper-supply.

13. And in an undertaking of such magnitude and rapid growth as that of the Indian Railways, it certainly will be prudent not to rely upon one source of supply alone, but to have a second source of supply to fall back upon, and thus to leave a broad margin for accidents and unforeseen contingencies.

14. Almost simultaneously with the construction of the first railways in India, the idea was started of increasing the durability of Indian woods by impregnating them with antiseptic substances. The experiments made in this respect have been numerous, and an account of them is given in paragraphs 24 to 40 of Dr. Warth's report of September last. The results have not thus far been satisfactory; nevertheless the impregnation of indigenous timber with antiseptic substances is the chief measure by which, for certain districts of North India at least, the supply of durable indigenous sleepers can be considerably increased.

15. In a report submitted to Government in January 1863, on the supply of indigenous sleepers in India, I drew attention to the necessity of testing the Himalayan pines in a systematic way as regards their impregnation with antiseptic substances; and I then said "the question is one of experiment, and the sooner this experiment is made on a sufficiently large scale, the better."

16. In a later report on the same subject of April 1870, I submitted my views on this subject as follows:—

"To supplement the supply of woods which are naturally

durable, it will be necessary, I believe, to undertake, on a large scale, the impregnation of the inferior pines with antiseptic substances. The species which I have mainly in view, and of which there are extensive forests, either leased or British, are the following :—

(1.) *Pinus longifolia.*
(2.) *Pinus excelsa.*
(3.) *Abies Smithiana* (Himalayan spruce.)
(4.) *Abies Webbiana* (Himalayan silver fir.)

"The larger portion of the forests of these kinds are at present without any value, there being no considerable demand for these woods, and any measures that will increase the demand will, in many ways, have a beneficial effect upon the management of the forests. For instance, in those tracts where the deodar is mixed with the inferior pines, the forest cannot be worked in a satisfactory manner if felling operations are limited to deodar; and in other parts, it will not pay to make roads and slides, unless a large quantity of timber is available for removal from one locality.

"In short, if we can manage to utilize the extensive forests of the inferior kinds of pines, it will be possible to place the working of the Himalayan forests upon a much more satisfactory footing. This is an advantage independent of increasing the supply of timber."

17. In 1875, the Government of India placed Dr. H. Warth, Collector of Inland Customs, Mayo Salt Mines, on special duty to work up the information which I had collected regarding the impregnation of timber, and the result was a report on the subject, which was published in the INDIAN FORESTER of July 1876.

In 1876, when Dr. Warth was at home on furlough, he was, at the suggestion of the Government of India, directed by the Secretary of State to examine certain impregnation works in Germany and Austria, and particularly to report upon the experience gained in these countries regarding the durability of sleepers impregnated with chloride of zinc and sulphate of copper. His report, which was dated December 1876, was printed in England.

And in July of this year, Dr. Warth was again, by the order

of the Government of India, placed upon special duty to prepare estimates for setting up works for impregnating the Himalayan pines with metallic salts. This last report is dated 14th September 1878.

18. As stated in paragraphs 28 and 29 of Dr. Warth's last report, a pneumatic apparatus for impregnating sleepers of *Pinus longifolia* with creosote was set up at Aligarh in 1868, and was worked successfully for some time. The creosote was imported from England, and its cost at the works is reported to have been from 4 to 6½ annas per gallon, not counting the cost of the iron tanks in which it is imported, and which, to the extent of the supply then obtained, were utilized or sold for full value. With a large steady annual supply of creosote, however, the disposal of these tanks for full value would be difficult, and this would increase the cost of creosote considerably. Even at the rates mentioned, the cost, reported from one rupee to two rupees two annas per sleeper, would, as a rule, be prohibitory. For the present, therefore, the idea of using creosote must be given up, though it is not impossible that hereafter it may be manufactured in India. The next best substitutes for creosote are certain metallic salts, *viz.*, corrosive sublimate, sulphate of copper, and chloride of zinc. The result of the experience regarding the preservative power of these substances is recorded in the three reports submitted by Dr. Warth on the subject, and particularly in paragraphs 10 to 18 of the memorandum of September last. There is every reason to believe that those substances will prove effective in India, provided the processes are applied with due care and with due consideration of all circumstances, particularly as regards the drying of the sleepers after impregnation. Regarding the cost of the process, reference is requested to paragraphs 41 to 58 of Dr. Warth's present report, which shows that with an annual outturn of 200,000 sleepers, the cost, including the cost of the metallic salts, will amount to 8 annas per broad-gauge sleeper.

19. There is good ground to believe that it will be possible to deliver annually 200,000 sleepers, or a larger quantity of the species mentioned above, at the impregnating works, at rates varying from Rs. 1-8 to 3, and that it will be possible to

sell the impregnated sleepers at the works at Rs. 3-8 a piece all round. This estimate relates to broad-gauge sleepers; but it can only be maintained if the demand is steady, so that all operations can be arranged accordingly. A fluctuating demand and sudden irregular indents for the delivery of large quantities at short notice must always result in increased cost of the sleepers.

20. The question now arises, whether at the rate named there is any prospect of selling annually 200,000 broad-gauge or their equivalent in metre-gauge sleepers in North India. In estimating the annual sleeper requirements of the lines in North India, it has been assumed that sea-borne sleepers can compete with indigenous sleepers to a distance from the port of from 500 to 600 miles. Thus, it has been assumed that the Rajputana line will be supplied with sea-borne sleepers as high up as Ajmere, and the Holkar and Neemuch lines as far as Neemuch. The Indus Valley line, the Great Indian Peninsula and East Indian Railways have been entirely omitted from the calculations.

21. The following statement shows the length of lines in North India open on 30th June last, and those in progress on that date, all those lines or sections of lines which, it is presumed, can be supplied economically by sea-borne sleepers being excluded :—

Length of lines open and in progress on the 30th June 1878.

Lines of Railway.	Open on the 30th June 1878.		In Progress.	
	Broad-gauge.	Metre-gauge.	Broad-gauge.	Metre-gauge.
	Miles.	Miles.	Miles.	Miles.
Punjab Northern State Railway	103*	.....	71	.....
Muttra-Hathras	.....	29	.....	.....
Rajputana (to Ajmere) ...	.....	400	.....	.....
Scindia (to Gwalior) ...	34	.....	41	.....
Neemuch (to Neemuch) ...	.....	.....	.....	133
Oudh and Rohilkhand (whole line)	544	.....	3	.....
Sindh, Punjab and Delhi Railway (to Multan) ...	553	.....	.....	.....
Total ...	1,234	429	115	133

* 103 miles, metre-gauge, line open on 30th June. The broad-gauge line 103½ miles, was opened on 6th October 1878.

22. The experience gained on the East Indian Railway justifies our estimating the life of a heart-wood sleeper of sâl at 14 years; but taking the sleepers now in use all round, 12 years may be taken as the average duration of sleepers. Accordingly, assuming one-twelfth as the annual figure for renewals, we have the following :—

Gauge.	Length of lines open on the 30th of June 1878.	Requirements for renewals in length of line.
	Miles.	Miles.
Broad	1,234	103
Metre	429	36

In these estimates no renewals are included for the lines now in progress and not yet open for traffic.

23. As regards new constructions, we may assume that during the next five years, 50 miles annually on the broad-gauge will be built in the Punjab, and 100 miles on the narrow-gauge in the North-Western Provinces. If we add to this the renewals, we find the total annual *requirements of sleepers in* round numbers as follows :—

Gauge.	Miles.	Sleepers, per mile.	Total sleepers.
Broad ...	150	1,800	270,000
Metre ...	135	1,800	243,000
Total ...	285	3,600	513,000

24. The following statement shows the cost of iron and wooden sleepers per mile imported by sea at the limits of land transport here assumed. The cost of the land transport is estimated at Rs. 15 per ton for 500 miles, which is equal to $\frac{1}{27}$ pies per maund per mile. This is rather too low an estimate, but it is adopted here in order to be on the safe side.

Cost of imported sleepers per mile of line at sea-port and up-country.

Sleepers of iron and wood imported from England at present prices, per mile of single line.	Iron pot sleepers.		Creosoted pine sleepers.	
	Broad-gauge.	Metre-gauge.	Broad-gauge.	Metre-gauge.
Weight of sleepers in tons ...	146	66	125	55
A.—Cost at sea-port.	Rs.	Rs.	Rs.	Rs.
(Reported present rates) ...	12,000	5,496	4,730	2,606
B.—Transport by rail—	Rs.	Rs.	Rs.	Rs.
To Multan ...	2,650	1,198	2,269	980
„ Ajmere ...	2,667	1,206	2,284	987
„ Neemuch ...	2,615	1,182	2,238	967
„ Jubbulpore	2,694	1,217	2,306	996
„ Allahabad ...	2,470	1,117	2,115	914
A + B.—Cost of sleepers per mile of single line—				
At Multan ...	14,650	6,694	6,999	3,586
„ Ajmere ...	14,667	6,702	7,014	3,593
„ Neemuch ...	14,615	6,678	6,968	3,573
„ Jubbulpore	14,694	6,713	7,036	3,602
„ Allahabad ...	14,470	6,613	6,845	3,520

Distance *viâ*	Miles.
Indus Valley and Sindh Railways ...	605
Bombay, Baroda and Central India and Western Rajputana Railways ...	609
Great Indian Peninsula and Holkar Railways.	597
Great Indian Peninsula Railway ...	615
East Indian Railway from Howrah. ...	564

25. It has been stated above that it will be possible to deliver broad-gauge impregnated sleepers at the impregnating works for Rs. 3-8 per sleeper. At 1,800 sleepers per mile, this would amount to Rs. 6,300 per mile. It will be explained

further on that the works will probably be set up near Delhi on the Jumna, and at Rajghat on the Ganges river; and it is obvious that from these points, or from points similarly situated, sleepers at Rs. 3-8 a piece (broad-gauge) will, even at the present low prices, compete successfully against sea-borne sleepers.

And it may be assumed as certain that creosoted pine sleepers will long continue to be imported at the rate of Rs. 2-8 per broad-gauge sleeper, but that the rate will again approach the usual one of Rs. 4.

26. Under these circumstances, it may reasonably be expected that the lines mentioned, the annual sleeper requirements of which during the next five years have been estimated at 270,000 broad, and 243,000 narrow-gauge, will be chiefly dependent upon the supply of indigenous sleepers, and these are, as already explained, the following :—

(1.) Sâl sleepers from Nepal.

(2.) Deodar sleepers from Kashmir.

(3.) Impregnated pine sleepers from the Jumna and Ganges rivers.

It cannot be expected that sâl and deodar sleepers (broad-gauge) will ever, to any large extent, be delivered at Rs. 3-8 per sleeper; they will always command from Rs. 4 to 5 delivered on the line.

Therefore, it is likely that at the rate mentioned (Rs. 3-8), there will be a certain demand during the next five years for at least 200,000 broad-gauge, or the equivalent of narrow-gauge sleepers a year. And it is obvious that a rise in the cost of sea-borne sleepers, and any increase in the import trade up-country which will raise the cost of carrying sea-borne sleepers inland, must necessarily increase the demand for indigenous sleepers.

27. It is impossible now to predict whether the pine sleepers proposed to be impregnated with metallic salts will attain a durability equal to that of sâl and deodar sleepers or of creosoted pine sleepers imported from England. This is the chief element of doubt in the matter; but the experience gained on this subject in Europe justifies the assumption that the difference in the life of creosoted sleepers and of sleepers

properly impregnated with the metallic salts named, will not be very considerable.

It has been proposed, in the first instance, to import from Europe, and lay down in India, a quantity of sleepers impregnated with sulphate of copper and chloride of zinc, and not to set up impregnation works, until the duration in India of sleepers thus impregnated has been determined by actual experience. It must be remembered that, if this plan is followed, 10—15 years at least must elapse before a reliable result can be obtained in this respect; and within this period, difficulties in regard to the sleeper supply in the inland districts of North India are sure to arise, which it may then perhaps only be possible to avert by cutting the last remaining stock of mature sâl and deodar in the Government forests. Such a contingency must by all means be avoided; the few remaining forests under the control of Government in Northern India, which still contain large quantities of mature sâl and deodar timber, must now be worked with sole regard to their maintenance and improvement as permanent sources for the supply of these woods; and, if this is done, large supplies of these woods will not be possible for many years to come. It seems to me that rather than risk being compelled to cut the last remaining stock of mature sâl and deodar in the Government forests, it would be wiser to risk the comparatively small capital outlay which the establishment of impregnation works in India involves. In paragraph 55 of his report, Dr. Warth estimates the total capital outlay on account of these works at Rs. 1,19,000, and his estimate is liberal in every respect.

28. It has been suggested to procure 40 miles of sleepers, *viz.*, 20 miles impregnated with chloride of zinc and 20 miles impregnated with sulphate of copper. According to the figures entered in paragraph 23, the cost of a mile of creosoted sleepers (broad-gauge) from England in Upper India amounts to Rs. 6,900, and it is not likely that sleepers impregnated with metallic salts, which must be procured specially for the occasion from the Continent of Europe, will be obtained for less. The experiment, therefore, will cost Rs. 2,76,000, and it could not well, with any reasonable chance of success, be

made on a smaller scale. But the result of the experiment will not necessarily give a reply to the question whether sleepers of the Himalayan pines, impregnated with special regard to the requirements of the climate of Upper India, will prove sufficiently durable to be employed with advantage. In the impregnation with metallic salts in a watery solution, the drying of the impregnated sleepers will probably be the chief difficulty to be contended against in India, and the process of drying the impregnated sleepers will require special care in the works proposed to be set up. If, for instance, the sleepers impregnated in Europe with sulphate of copper and chloride of zinc were not properly dried, they would split and thus prove unsuitable. Again, some of the Himalayan pines will probably be found to be more useful sleeper woods when impregnated than the European woods which are ordinarily used for impregnating with metallic salts.

29. The total cost of Himalayan pines impregnated in India for 40 miles of broad-gauge line will, at Rs. 3-8 per sleeper, be Rs. 2,52,000. The laying of these as an experiment will, in due time, give a more direct and practically useful result than the sleepers procured from Europe: and if, as I have no doubt will be the case, impregnation in India proves successful, almost any quantity of sleepers thus impregnated can be turned out annually, for the forests of the species mentioned are very extensive, well-stocked, and nearly untouched. At present they are almost valueless for export. I submit that the right thing to do is to make both experiments; to set up the impregnation works, and to procure 40 miles of sleepers impregnated with metallic salts from Europe. Final results regarding the durability in India of sleepers impregnated with metallic salts, can in either case not be obtained under 10 to 15 years; and this being so, it is clearly best to make the experiment as complete as possible.

30. In case it should be decided to accept the proposals now submitted, and to set up works in Upper India, I would suggest that, before the copper cylinders are purchased, some further data be obtained from France and Italy regarding the experience obtained on the railways in those countries, with

reference to the durability of beech and pine sleepers impregnated with sulphate of copper by the pneumatic process. It is generally known that the results have been satisfactory; but specific data are wanting from those countries, and should be obtained. The forest officers who have received their professional education in France are all familiar with French, and any one of them who may be at home on leave would be competent to undertake this duty. The data should be collected on the spot at the head-quarters of the different railways; the impregnation works should be visited, and a collection be made of all recent publications in France and Italy bearing on the subject. A statement of the lines on which sleepers thus impregnated are used, and the annual outturn of such sleepers from the works, should be given as far as practicable. The opportunity should be taken to enquire into the extent to which Boucherie's process is used, and the experience gained regarding the results obtained by that process. Paragraph 54 of Dr. Warth's report shows that the cost of the copper cylinders and bronze frames alone amounts to £4,540, whereas the total cost of the machinery expected from England will not exceed £6,400. Before incurring this part of the outlay, therefore, it will be well to procure by direct enquiries on the spot the latest experience regarding the durability of sleepers impregnated with sulphate of copper by the pneumatic process in France and Italy.

31. A few remarks should now be made regarding the question where the works should be established. On this subject I have consulted Mr. Greig, the Conservator of Forests, Central Circle, in the North-Western Provinces, and Captain Bailey, the Conservator of Forests of the School Circle, and the following remarks are chiefly based upon the data furnished by these officers. The four species, the wood of which it is proposed to impregnate in the first instance, have been mentioned already (paragraph 16). The commencement will probably be made with chir (*Pinus longifolia*), extensive forests of this tree being close to the banks of several streams which admit of floating, chiefly in the basin of the Tons and Ganges rivers. The works should, if possible, be set up at the point where

water carriage ceases, and it will, therefore, be best to establish two separate factories, one for the sleepers from the Tons, the other for those from the Ganges river. Eventually, I have no doubt that the wood of the other species also will be brought down and impregnated. These kinds also will, in the first instance, be procured from the Tons and Ganges forests, so that the following remarks are applicable to the supply of sleepers of these kinds also, except that they grow at higher elevations, and that the working season in the forests in the case of these woods is not in winter, but in spring, summer, and autumn.

32. For the timber from the Tons river, the works will probably have to be set up at Jagadri, or at a place near Delhi. The sleepers which come down singly are caught and rafted at Dagh Pathar below the junction of the Tons with the Jumna river; the rafts are then floated down the Jumna river and Western Jumna canal. If the works were established at Jagadri, they would be near the canal and the Sindh, Punjab and Delhi Railway, and the sleepers would reach that place in about 105 days from the time of being launched in the forest. There would be little chance of interruption on the 28 miles of canal from its head to Jagadri, as this portion of the canal is broad. It is estimated that the cost of the sleepers delivered from the forest at Jagadri would be under Re. 1-12 per sleeper.

33. If it should be decided to establish the works near Delhi, then the best place would be at a station on the Rajputana line, opposite Metaika-phal, where the railway crosses the Western Jumna Canal. Rafts can usually be floated as far as this; but they may occasionally be stopped by insufficiency of water at Rohilla Khan Serai, 5 miles up the canal, in which case the sleepers would either be floated singly or carted to the factory. In any case, the cost of the unimpregnated sleepers near Delhi would be under Rs. 2-4 a piece. The transit fom Jagadri to Delhi would ordinarily take about 15 days, and the risk of delay would be somewhat greater than in the case of Jagadri. A certain amount of risk of delay is inseparable from floating on the canals; but by good management, this may to a great extent be obviated. The canals are

usually closed for cleaning in January, and by that time the floating of the year should be completed.

34. The forests of *Pinus longifolia* are at low elevations in the valley of the Tons, and work in them can only be carried on from October to April. Beginning work in October, all sleepers on the bank of the river by 1st March could be launched and floated to Jagadri by June; those sawn and carried in March and April could be launched in September and delivered at the works by December. Thus, the great mass of the sleepers would be delivered at the works during two seasons of the year, *viz.*, in June and December.

35. It is not at present considered probable that it will be found advantageous to send the sleepers to Delhi by the river. On that route the rafts are sent down by canal to Daduper, (14 miles below the canal head-works). Here, when waste water is available, the rafts are broken up, and the sleepers carried over the escape bund; they are then re-rafted and sent down the escape channel to the Jumna. When there is not sufficient water in the escape channel, the rafts are sent on 5 miles further to Madelpur, where they are broken up, and the sleepers are carted 3 miles to the Jumna. On reaching the river, they are re-rafted and floated down to Delhi. But this route is considered much more uncertain than that to Metaika-phal by the canal.

36. Two other places have been thought of—Saharanpur on the Eastern Jumna canal, and Rampur Mandi in the Dún on the Jumna river. The Eastern Jumna canal is not adapted for navigation, owing to numerous masonry weirs in its course not being provided with locks. No rafts would live over these weirs, and single sleepers could not be allowed to go over them, as the weirs would not stand it. It would, however, probably be possible to fit the canal for floating single sleepers by erecting floating booms above each weir and constructing slides of wood over the weirs. This would, however, increase the expense, and the cost of sleepers delivered at Saharanpur would be greater than at Jagadri.

37. Rampur Mandi on the Jumna river below its junction with the Giri, or rather a place opposite to it in the Dehra

Dún, would have the great advantage of being nearer the forests. There would be no risk of detention, and the delivery of the sleepers at the works could be better regulated. The works would be under constant supervision by the Conservator of Forests of the School Circle; they would not necessarily form a separate charge, as would be the case if they were established at Jagadri or near Delhi, and consequently the item of officers' salary, which in the estimate drawn by Dr. Warth, (paragraph 56) amounts to Rs. 12,000 out of a total annual outlay of Rs. 47,527 for working charges, might be considerably reduced.

38. The drawback to this plan would be the expense of carting the sleepers to Saharanpur, which would cost at least 6 annas per broad-gauge sleeper. But if a branch railway were built from Saharanpur to the foot of the hills below Chakrata, this objection would, to a great extent, be obviated. The line would probably pass within 3 or 4 miles from the place, and a tramway might be run into the works. On the assumption that 100,000 sleepers were procured from the Ganges, and the same quantity from the Tons, about 7,000 tons of timber would be carried annually by that line—a distance of about 40 miles to Saharanpur. The freight might be fixed high, so as to yield a gross income of say Rs. 20,000 a year to the railway, which would be an acceptable addition to the earnings of the railway, considering that most of the traffic on that line would be up-country. This would add 3 to 4 annas to the cost of the sleepers, which additional charge would probably be counterbalanced by the other advantages of the place. It is estimated that the sleepers from the forest might be delivered from the forests at Rampore Mandi at from Re. 1-8 to Re. 1-10 each.

39. The sleepers brought from the Ganges would also be cut and sawn up between October and May. Mr. Greig hopes that it will be possible to float them down the Ganges to Rajghat, where the Oudh and Rohilkhand Railway crosses that river. At that place they would be delivered twice a year, in May and June and in October and November. The chir forests on the feeders of the Ganges are very extensive;

those in the Alaknanda and Bhillang valleys would probably be taken in hand first; and Mr. Greig hopes, if all goes well, to be able to deliver the unimpregnated sleepers at Rajghat at the rate of Re. 1-8 to Re. 1-10 per broad-gauge sleeper.

If these anticipations are realized, then the works for the timber from this river will be established at Rajghat, and arrangements will be made for an annual delivery at that place at the outset of 100,000 sleepers.

40. If the proposals here submitted are approved, then the first step should be to put the forests in order which are to yield these sleepers, by making roads, protecting them from fire, and preparing a preliminary plan of working; and the more time can be given for this preliminary work the better. As far as the interests of forest administration are concerned, nothing would be gained by hurrying on the establishment of these impregnation works, provided it is decided to make a commencement, as soon as all needful preparations have been completed. Indeed, the present time is by no means favourable to the undertaking, on account of the unusually low prices of both iron and timber sleepers imported from Europe.

41. There can be no doubt that, as far as the railway interest is concerned, it will be wise and prudent to give encouragement to all measures which may tend to increase the supply of indigenous sleepers. But the necessity of these measures will, perhaps, be felt more keenly when the cost of imported sleepers has risen to a higher figure than it stands at present.

42. The practical question which now calls for decision is, whether it is likely that there will be a demand in North India for an annual outturn of 200,000 broad-gauge sleepers, impregnated with metallic salts. As soon as this question has been settled in the affirmative, the preliminary steps here indicated should at once be taken; and when the works have once been commenced, it may be confidently predicted that the business, if properly managed, will develop largely; and that by gradually adopting improved methods of impregnation, the wood of the Himalayan pines will be made as durable as

that of deodar or creosoted pine from England. In the same measure as success in this respect is attained and recognized, the demand for these sleepers will increase; and thus the object will eventually be gained of utilizing the trees associated with deodar in the forests, and of thereby placing the working of these deodar forests upon a sound and satisfactory footing, while at the same time largely increasing the supply of indigenous sleepers. And when all the experiments proposed to be made have been completed, and when the system of impregnation most suitable for India has become a regular matter of routine, it will then, perhaps, be possible to make the impregnation works over to private enterprize, and for Government to withdraw from this part of the business. But the commencement must be made by Government.

Statement showing the number of Sleepers supplied to State Railways by the Forest Departments of the North-Western Provinces, the Punjab, and the Central Provinces up to 1st April 1878, and in the case of Bengal and British Burma up to 1st April 1877.

Name of Railway.	Description of Sleepers.	North-Western Provinces.	Punjab.	Central Provinces.	Bengal.	Burma.	Total.
Rajputana State Railway—							
Delhi District	Deodar ...	441,029	58,590	.....	.....	.....	499,619
Agra „ ...	Deodar ...	768,234	.....	.....	.....	.....	768,234
	Sâl ...	25,491	.....	.....	.....	.....	25,491
	Sâl and Chir ...	22,900	.....	.....	.....	.....	22,900
Ajmere „ ...	Dhaura ...	961	.....	.....	.....	.....	961
	Deodar ...	94,984	.....	.....	.....	.....	94,984
	Sâl ...	550	.....	.....	.....	.....	550
	Sâl and Chir ...	10,102	.....	.....	.....	.....	10,102
Punjab Northern State Railway ...	Deodar ...	.....	105,120	.....	.....	.....	105,120
Indus Valley State Railway ...	Deodar ...	.....	18,866	.....	.....	.....	18,866
Holkar State Railway	Dhaura ...	.....	.....	746	.....	.....	746
	Anjan ...	.....	.....	2,062	.....	.....	2,062
	Hardu ...	.....	.....	2,385	.....	.....	2,385
	Bija Sâl ...	.....	.....	1,077	.....	.....	1,077
Wardha Valley Railway ...	Teak ...	.....	.....	63,921	.....	.....	63,921
Northern Bengal State Railway	Sâl ...	.....	.....	.....	41,336	.....	41,336
	Saj ...	.....	.....	.....	723	.....	723
	Other kinds ...	.....	.....	.....	305	.....	305
Rangoon and Irrawaddy State Railway ...	Teak ...	.....	.....	.....	.....	156,138	156,138
	Other kinds ...	.....	.....	.....	.....	19,402	19,402
	Total ...	1,364,251	182,576	70,191	42,364	175,540	1,834,922

Statement showing the number of Sleepers supplied to State Railways by the Forest Departments of the North-Western Provinces, the Punjab, and the Central Provinces up to 1st April 1878, and in the case of Bengal and British Burma up to 1st April 1877.

Description of Sleepers.	North-Western Provinces.	Punjab.	Central Provinces.	Bengal.	Burma.	Total.
Deodar ...	1,304,247	182,576	...	...	...	1,486,823
Teak... ...	...	...	63,921	...	156,138	220,059
Sâl	26,041	...	...	41,336	...	67,377
Sâl and Chir ...	33,002	...	...	...	...	33,002
Bija Sâl ...	...	...	1,077	...	...	1,077
Saj ...	...	...	...	723	...	723
Dhaura ...	961	...	746	...	...	1,707
Anjan ...	...	...	2,062	...	...	2,062
Hardu ...	...	...	2,385	...	...	2,385
Other kinds ...	...	...	...	305	19,402	19,707
Total ...	1,364,251	182,576	70,191	42,364	175,540	1,834,922

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Sulpiz Kurz,

Mr. S. Kurz, late Curator of the Herbarium at the Botanical Gardens, Calcutta, and one of our most valued contributors, succumbed to the effects of a tropical climate at Penang on the 15th January 1878. We feel sure the following sketch of his life, read by Dr. D. Brandis at the Meeting of the Asiatic Society of Bengal, will interest our readers:—

Sulpiz Kurz, Curator of the Herbarium at the Botanic Gardens, Calcutta, was born at Augsburg, in Bavaria, on the 5th May 1834. His father died early, and the boy attended school at Munich, where his mother had settled. At an early age he commenced collecting objects of natural history, especially insects. After leaving school he attended lectures at the University of Munich, and chiefly devoted himself to the study of Botany, Mineralogy and Chemistry. In 1854 misfortunes in his family compelled him to abandon his studies, and he went to Holland where he worked as an apothecary, and, after mastering the Dutch language, enlisted in the Subordinate Medical Service of the Dutch Colonial Army. He landed at Batavia in September 1856, and was sent to Banka in March 1857, where he remained two years. During that time his work was light, and he was able to explore the island and to make botanical collections. In 1859 he was re-called to Batavia and joined the Military Expedition to Bori in Celebes. In September 1859 Kurz returned to Batavia, and was appointed as an Assistant on the Staff of the Botanic Garden at Buytenzoorg. Here, for the first time in his life, he had the advantage of working under the guidance of other botanists, and with the assistance of a large library and a rich herbarium,

he devoted himself principally to Ferns, Bamboos, Musaceæ, Pandaneæ and other difficult groups. A few years later Dr. Thomas Anderson, the Superintendent of the Botanical Gardens, Calcutta, came to Java in order to study the system of Cinchona cultivation which had then for some time been established by the Dutch authorities. He induced Kurz, with the permission of the Dutch Government, to accept the appointment, which he held at the Herbarium of the Calcutta Botanical Gardens until his death. In October 1863 Kurz left Java, and joined his new appointment at the Gardens early in 1864.

Before his transfer to Calcutta he had not published much; a few papers only on the vegetation of Banka and other matters had been printed in the "*Naturkundige Tydschrift voor Nederlandsch Indie.*" In Calcutta, however, he commenced a series of important botanical publications, which appeared in English and Continental Periodicals, chiefly in the London Journal of Botany, the Proceedings of the Linnean Society, in Miquel's Annales, the Flora of Regensburg and the Botanische Zeitung. But his later and most important papers were published in the Journal of the Asiatic Society, of which he became a member in 1869.

In 1866, Kurz was deputed by the Government of India to Port Blair, in order to study the vegetation of the Andaman Islands. He spent the months of April and May on that duty, and the results of his explorations were recorded in a most valuable Report which was published by Government in 1870. While engaged in examining the interior of South Andaman, he was seized by the Burman convicts, whom the Superintendent of Port Blair had given to assist him in his work, and was left tied hand and foot in the jungles on the ground. These and subsequent circumstances, which prevented the more extensive excursions which he had projected through the islands, obliged Kurz to return to Calcutta sooner than he had intended.

In 1867, the Government of India decided to employ him on the preparation of a hand-book, intended chiefly for the use of forest officers, of the trees, shrubs and climbers grow-

ing in the forests of British Burma. To this new task, Kurz devoted himself with his usual ardour and enthusiasm, and his researches regarding the Flora of Burma may justly be regarded as the most important work of his life. From December 1867 to June 1868, Kurz explored the forests in the province of Pegu and part of those in Martaban. But when after his return to Calcutta he examined and arranged the rich materials collected by him, he found that many doubtful points remained, and he was accordingly deputed on a second tour to the same districts, which lasted from December 1870 until May 1871.

Besides the materials collected by himself, Kurz had the advantage of consulting large collections made by others in Burma, and he was thus enabled to describe numerous new genera and species. A number of Burmese plants collected by him are described by other Botanists, and deservedly bear his name. Between 1872 and 1877 he contributed two series of valuable papers to the Journal of the Asiatic Society. One series he called "New Burmese Plants," and the other, "Contributions towards the knowledge of the Burmese Flora." A general account of his researches was embodied in a quarto volume published by Government in 1875, under the title "Preliminary Report on the Forest and other Vegetation of Pegu." This work contains an admirable account of the vegetation in all parts of that province, as well as a most useful list of vernacular (Burmese) names of plants with their systematic names.

The chief results of his labours in regard to the Burma Flora, however, were embodied in his Forest Flora of British Burma—a work, regarding which it is not too much to say, that it has placed the name of Kurz in the first rank of Indian Botanists. This work was published towards the close of last year in two volumes, by order of the Government of India. It contains full and clear descriptions of 2,000 species, and will, for a long time to come, remain a standard work of reference for all interested in the vegetation of British Burma and the adjacent countries.

In 1875, Kurz took three months' leave, and devoted it to a botanical exploration of the Nicobars, but exposure and fatigue in the unhealthy climate of those islands brought on a severe attack of fever which much weakened his constitution. In 1876, he contributed to the *Journal of the Asiatic Society* a paper on the Vegetation of the Nicobars, based chiefly upon the collections made by the Austrian Naturalists, attached to the Novara Expedition. These collections had been sent to him for publication by the Director of the Imperial Museum at Vienna.

On the 12th November 1877, shortly after his Forest Flora had been published, Kurz left Calcutta on leave to visit the Straits Settlements. He reached Penang on the 12th December, but was taken ill and died at that place on the 15th January 1878, at the age of 43 years. An uninterrupted residence in the tropics of 21 years, and constant exposure on his botanical explorations, had undermined his constitution. His ardour in the pursuit of Botany was irrepressible, and he rarely thought of health or comfort on his expeditions.

He was Member of several learned Societies; his fellow Botanists in England, the Continent of Europe and in India will mourn his loss, and by many of his friends outside the circle of those interested in science, he will long be remembered by his enthusiastic and single-minded devotion to the science, which, from early youth, was the aim and object of his life.

Report on the Investigation and Collecting of Plants and Seeds of the India-rubber Trees of Para and Ceara and Balsam of Copaiba.

By ROBERT CROSS.

To the Under-Secretary of State for India.

Grove Street, Edinburgh, 29th March 1877.

Sir,

Respecting the service on which I have recently been employed in the collecting of plants yielding the Para India-rubber of commerce, I now take the liberty to forward a detailed account of my proceedings.

On the 19th of June 1876 I left Liverpool by the "Red Cross" Steamer "Cearense," which, after calling at Havre and Lisbon, sailed direct for Para, which was reached on the 15th of July. This city is situated on the southern bank of the River Amazon, which, at the point where it debouches to the sea, has a breadth of 33 miles. Para is distant 80 miles from the ocean.

The population, numbering about 40,000, are chiefly engaged with the despatch of import and export produce. Everything is very dear, and notwithstanding the reputed fertility of the Amazon valley, *I found that nearly all the necessaries of* life are imported. Thus, butter and fish come from Norway, rice and flour from the United States, while sugar, coffee, and *mandiocca* are brought from the southern ports of Brazil. Import duties are high, and so also are those on produce exported, amounting in some things, such as rubber, to 25 per cent. of the value of the article. The houses are mostly built of mud and roofed over with tiles. The windows are chiefly formed of wood, hinged at the top, and pushed out from below, whence the inmates, unseen, obtain views of the street and passers-by. Throughout the course of the day many of the occupants are invariably congregated behind these window lids.

The great bulk of the citizens go about more ostentatiously dressed than the people of London, the attire considered essential being fine black coat and hat, with snow-white ironed vest and trousers, and fancy French boots. Those who do not con-

form to this style of dress are stared at. Even at the beginning I did not agree with the fashion, and afterwards was farther removed from it by being almost daily bedaubed over with the mud of the *gapós*. Coloured females and slaves may be seen stepping into carriages perfectly loaded with large necklaces and glittering ornaments, and even the families of foreign residents are frequently dressed in the most excessive and extraordinary manner.

The phase of slavery that exists is in so mild a form that it is at first not observed. In very many instances the slaves are allowed to hire themselves out on condition of paying their owners a certain sum of their daily earnings. The whole system is evidently dying out more rapidly than the Government laws enacted for its abolition require it to do.

Merchandise and other effects are removed from one place to another in the old primitive way, thus employing many hands, who earn high wages. Emigrant Portuguese, of whom there are about 5,000, are mostly the carriers, boatmen, and shop-keepers of the place. The supply of water for the city is carted through the streets in barrels, and sold at the rate of three-halfpence per *poto*. The *poto* contains 21 English imperial pints. Within 12 hours after being deposited, the water is found to precipitate a greenish substance amounting to nearly one-fourth the quantity, which is not removed even if filtered through several folds of stout cloth. In the courtyards of the majority of the houses are open cess-pools, which in such a glowing atmosphere may assist in developing much sickness. Dysentery, yellow fever, and various other forms of a typhoid character appear to be permanent, although of late there have been no serious outbreaks, and the place is reported more healthy than formerly. Tetanus and other forms of nervous affections are of frequent occurrence, especially among the native-born population. I have no doubt that Para is far more unhealthy than any city in India. It may not be so naturally, but by a combination of circumstances; such I believe to be the case.

I found on arrival, after considerable inquiry, that the great field for caoutchouc collecting was the province of Para, and

the islands which are scattered over the lower portion of the Amazon River. Chief of these is the Island of Marajo, which is about the size of Holland. A good deal of the rubber from the Rio Negro, Madeira, and other tributaries, appears to come in the form of "negrohead," or *sernamby*, while the Para region seems to produce to a greater extent the finer kinds of smoked biscuit rubber, the preparation of which is attended to more carefully, besides which the Para tree is reported to be a different variety. Its milk leaves no very prominent stain on the hands or clothing, while the milk of some of the varieties of rubber of the Upper Amazon gives a black ink-like mark to the hands and clothes of collectors. Black rubber is stated by some to be deficient in recoil or elasticity. In order to form and establish a collection of plants, and for the purpose of making the various observations on the soil, climate, and mode of collecting and preparing the rubber, it was necessary to obtain a place to live in while so employed. Everyone told me I would experience great difficulty in finding a dwelling, and this proved true. After travelling round Para, and searching for about eight days, I succeeded in hiring a house, but at a very high rate, as the place was large, and adapted for a family with attendants and slaves. However, it was secure, and offered every facility for my various requirements, which was important. My next work was to examine the district where the rubber trees grew. Mr. Henderson, who was known to Dr. Spruce, kindly introduced me to an old rubber collector, called Don Henrique, who undertook to lead the way to the *seringal*, as the rubber locality is termed, but after disappointing me twice, I resolved to lose no more time, and procuring from him the services of a lad as guide, I commenced to inspect the forest. On the 25th of July I made a preliminary journey to the region where the trees were wrought.

The land around Para, including where the city stands, rises from the banks of the river southward in the form of gentle undulations, indented, however, in many places by deep gully-like natural ditches, called *gapós*, which often penetrate for many miles into the interior of this vast forest region, and are filled daily by diurnal tides. To those navigable by canoes or

sailing craft the term *ajarape* is often applied. The intervening land between the *gapós* is frequently flat and moist, and owes its origin first to tidal deposits, and afterwards is raised higher by the decayed remains of successional rank growths of vegetation. On the elevated lands beds of white sand, 20 feet in depth, are met with, covered with a layer of decayed vegetation. At a similar level to this we find a deposit approaching to clay or very fine sand and mud, with here and there masses of sandstone or granite cropping out. In every direction where a view can be obtained, the country is seen to be covered by dense exuberant forest. Leaving Para, I travelled over the high ground for several miles, until the primitive forest was reached, and then went down towards the *gapós*. Following through the wood, a path used by the caoutchouc collectors, we soon came to a large tree in a state of decay, which had been tapped many times. At first sight I felt extremely puzzled and perplexed at the appearance it presented. From the ground up to a height of 10 or 12 feet the trunk was one swollen mass of warty protuberances and knots, covered with thick scales and flakes of hard dry bark.

This singular state of growth, the result of the practised system of tapping, has not yet been recorded by any one, and so was to me unexpected. A few minutes of careful examination soon showed the real cause of these deformities. The collector makes use of a small axe-like implement an inch broad. At each stroke he cuts through the bark and into the wood for fully an inch. Hundreds of these are made in the wood of each tree in the course of a few years, and cannot heal under any circumstances; but a layer of wood is formed over the injured part, at the expense of the bark and general vitality of the tree. The newly-formed wood is again cut into and splintered, and so the process is repeated on each successive layer until the trunk becomes merely a mass of twisted wrinkled wood, with very thin insipid bark. In this condition hardly any milk flows from the cuts; and, although for years a few green leaves may continue to sprout from the points of the twigs, yet the tree may be considered as dead, and, in fact, finally withers away. It is, therefore, the injury

done to the wood, and not over-tapping, which lessens the flow of milk, and ultimately causes the death of the tree. The cuts in the wood are of course unnecessary, since the milk is met with only in the bark. The healing over process which afterwards takes place is similar to that seen where a branch has been lopped from a trunk. The wood is compact and rather hard, and for this reason the tree lives on for a number of years, although cut and hacked every season; but the flow of milk becomes so lessened that many are practically abandoned for years before they die. This and several large adjoining trees were growing in moist deep heavy soil of a fertile character, but quite out of the reach of any inundation.

On the 2nd of August I went in search of plants, and descended to the region of the *gapós*. It had rained a good deal previously, and the collector's footpaths were ankle deep with mud. After wading several little pools, we came to a deep *gapó*, into which the tide flowed. It was connected with many lesser watercourses that formed a kind of network, extending over a wide district of forest-covered country, the more elevated parts of which were raised only from three to four feet above the highest tides. A considerable number of rubber trees grew along the margins of both the larger and smaller streams, intermixed with cacao and forest trees. Three were observed, the base of the trunks of which were flooded to a height of one foot, yet the roots seemed to run up to the brow of the bank, and no matted rootlets were observed, as is the case with the willow tree when growing on the margin of a rivulet. Most of the others occupied dry situations. Those *gapó* ditches were lined with soft rich mud, without doubt possessing great fertility. The exhalations from such places, shrouded by a forest growth of 80 or 100 feet high, were sensibly felt, and on nearly every occasion when I visited those localities I experienced slight attacks of fever afterwards. The collectors, also, during the working season are often indisposed from the same cause. Although the forest was excessively damp, yet tapping was being carried on, as a man was seen mixing up some clay at the side of a *gapó*.

A number of good plants were met with beneath the oldest trees. The seedlings did not usually grow in any place where the ground was covered by more than two or three inches of water at flood tide. However, by far the greatest number were met with on sites above the reach of the highest tides. I measured a few of the largest trees, all of which had been tapped for periods varying from 5 to 15 years. Those found growing in shallow *gapó* ditches are preceded by an asterisk. The circumference of each one yard from the ground was as follows :—

	Ft.	In.		Ft.	In.
No. 1	.. 6	9	No. 7	.. 4	0
No. 2	.. 6	10	No. 8	.. 5	10
No. 3	.. 4	7	No. 9	.. 4	0
No. 4	.. 3	0	No. 10	.. 4	6
*No. 5	.. 5	10	No. 11	.. 4	8
No. 6	.. 5	8	*No. 12	.. 2	8

Most trees occurring within the limits of the worked districts are tapped if possessing a diameter of six or eight inches. Regularly-tapped trees, as a rule, do not exceed 60 feet in height.

August 7th.—I went in search of more plants, and on the 10th made another collection. About 2,000 in all were obtained, but a number had to be rejected. I had cases previously made, so that I was able to plant the plants in them without delay. The soil consisted of decayed leaves brought from the forest. The rougher portion was charred and put in the bottoms of the cases to serve as a sort of drainage. Then a layer mixed with some wood ashes was placed above the plants planted therein. Four cases, containing upwards of 1,000 plants, were finished in this way, one being reserved for copaiba or any other sort of rubber plants I might meet with. While the plants were being established I commenced a series of experiments, in order to ascertain how the tree might be readily multiplied in a simple rough way by any person not specially acquainted with the principles of propagation. Two separate beds, the one of brown sand, the other of decayed leaves, were formed. The terminal portion of

shoots, but with a bud at the lower end, were planted in the beds in a reclining position, with only two inches of the points above the ground. Owing to the great distance between the buds, consequent on vigorous growth, many of the cuttings were a foot or more in length. At the same time a number were set deeply in an open vessel containing only rain water. The cuttings in the sand bed were the first to grow, and soon made strong shoots and root fibres. Those in the leaf mould pushed more slowly, but developed green leaflets of great substance. The cuttings placed in the water had a small portion of tap root at the base, as the object was to determine if the roots would actually develop in water alone. Within fourteen days these plants had several roots formed, and one or two rather weak growths came up, but a few days after I had thrown into the water some burnt earth and wood ashes the increase in vigour was very apparent. After these experiences I felt convinced that the Para rubber tree delights in abundance of moisture and rich fertile deposits.

Method adopted in tapping the trees.—When the plants were somewhat established, I resolved to examine attentively the process of tapping as practised by the caoutchouc collectors. In the investigation of this subject I travelled over a very wide extent of flat forest country, much divided by miry hollows and tidal *gapós*, which stretched along the bank of the river Guamá. Although this river is at least three times as broad as the Thames at London Bridge, it is not to be seen on any ordinary map. In the region alluded to there were hundreds of trees wrought by different collectors, each of whom had a separate piece of land to work on. When on these excursions, I had to go away from my place of abode at about three o'clock in the morning, as I had some miles to travel over paths not always in good condition, and it was necessary to be as near as possible to the spot where the tapping operation was performed, because the collectors begin to work immediately at daybreak, or as soon as they can see to move about among the trees. They say the milk flows more freely and in greater quantity at early morn. I do not attach

much importance to this statement, but I have recorded it. Another and more probable reason is, that as rain often falls about two or three o'clock in the afternoon, the tapping must be done early, as in the event of a shower the milk would be spattered about and lost. The collector, first of all, at the beginning of the dry season, goes round and lays down at the base of each tree a certain number of small cups of burnt clay. At the lesser trees only three or four are put, but at the larger ones from eight to twelve are deposited. The footpaths leading from tree to tree are likewise cleared of sapling growths, and the bridges over the *gapós* formed at each place by the trunk of a tree are, where necessary, replaced. On proceeding to his work the collector takes with him a small axe for tapping, and a wicker basket containing a good-sized ball of well-wrought clay. He usually has likewise a bag for the waste droppings of rubber, and for what may adhere to the bottoms of the cups. These promiscuous gatherings are termed *sernamby*, and form the "negro-head" of the English market. The cups, as already stated, are of burnt clay, and are sometimes round, but more frequently flat or slightly concave on one side, so as to stick easily when with a small portion of clay they are pressed against the trunk of the tree. The contents of 15 cups make one English imperial pint. Arriving at a tree, the collector takes the axe in his right hand, and, striking in an upward direction as high as he can reach, makes a deep upward sloping cut across the trunk, which always goes through the bark and penetrates an inch or more into the wood. The cut is an inch in breadth. Frequently a small portion of bark breaks off from the upper side, and occasionally a thin splinter of wood is also raised. Quickly stooping down he takes a cup, and pasting on a small quantity of clay on the flat side, presses it to the trunk close beneath the cut. By this time the milk, which is of dazzling whiteness, is beginning to exude, so that if requisite he so smooths the clay that it may trickle directly into the cup. At a distance of four or five inches, but at the same height, another cup is luted on, and so the process is continued until a row of cups encircle the tree at a height of about six feet from the ground.

Tree after tree is treated in like manner, until the tapping required for the day is finished. This work should be concluded by nine or ten o'clock in the morning, because the milk continues to exude slowly from the cuts for three hours or perhaps longer. I may state that there is a great difference among collectors in the performance of those duties. Some take care to get good clay previously and incorporate it well, so that a very small portion is needed to lute the cups to the trunks; they also work with neatness and intelligence, and invariably collect a good quantity of milk. Others, again, do not take the trouble to prepare clay beforehand, but merely scrape up a handful when they require it at the side of a *gapó*, which is often of little consistence, so that a large quantity is required to fasten the cups. This class of collectors have often many fragments of clay or other impurities in their milk, the result of not following a proper method of working. The quantity of milk that flows from each cut varies, but if the tree is large, and has not been much tapped, the majority of the cups will be more than half full, and occasionally a few may be filled to the brim. But if the tree is much gnarled from tapping, whether it grows in the rich sludge of the *gapó* or dry land, many of the cups will be found to contain only about a tablespoonful of milk, and sometimes hardly that. On the following morning the operation is performed in the same way, only that the cuts or gashes beneath which the cups are placed are made from six to eight inches lower down the trunks than those of the previous day. Thus each day brings the cups gradually lower until the ground is reached. The collector then begins as high as he can reach, and descends as before, taking care, however, to make his cuts in separate places from those previously made. If the yield of milk from a tree is great, two rows of cups are put on at once, the one as high as can be reached, and the other at the surface of the ground, and in the course of working, the upper row descending daily six or eight inches, while the lower one ascends the same distance, both rows in a few days come together. When the produce of milk diminishes in long wrought trees, two or three cups

are put on various parts of the trunk, where the bark is thickest. Although many of the trees of this class are large, the quantity of milk obtained is surprisingly little. This state of things is not the result of overtapping, as some have stated. Indeed I do not believe it is possible to overtap a tree if in the operation the wood is not left bare or injured. But at every stroke the collector's axe enters the wood, and the energies of the tree are required in forming new layers to cover those numerous wounds. The best milk-yielding tree I examined had the marks of twelve rows of cups which had already been put on this season. The rows were only six inches apart, and in each row there were six cups, so that the total number of wood cuts within the space of three months amounted to seventy-two. It grew close to a *gapó* only eight inches above high-tide mark, and being a vigorous tree, the cups were usually well filled, but with two years or so of such treatment the tree would probably be permanently injured. It has been supposed that the quality of the milk is better in the dry season than during the rains. Such is the case with some vegetable products; but, as regards India-rubber, there ought not, I think, to be any appreciable difference. In the rainy season the milk probably contains a greater proportion of water, but, on the other hand, I am of opinion that then a larger quantity of milk flows from the tree. No doubt the dry season is the most suitable for caoutchouc collecting, although, wherever a plantation is formed with preparing house, convenient tapping may certainly be always carried on when the weather is fine. It is a common report that the trees yield the greatest quantity of milk at full moon. In order to ascertain this, a number of very careful experiments would require to be made, extending over one or two years. Even if such an assertion was found to be true, it would probably make little difference, as tapping will have to be carried on when circumstances are most favourable.

There are two other methods adopted in tapping, which are chiefly confined to the Upper Amazon and tributaries. Both are exactly on the same principle, the materials used being only a little different. The loose outside bark of the tree

is cleaned off to a height of about three feet. Beneath, a gutter or raised border of clay is pasted or luted to the trunk, enclosing one-half or the entire circumference. Cuts are thickly made in the bark above this, from which the milk flows down to the gutter, whence it is conveyed to fall into a calabash conveniently placed. The other mode is by winding round the trunk the stout flexible stem of a climber, and claying it round securely so that no milk may escape between the trunk and the climber. These plans are not extensively adopted, and can only be successfully put in practice where the trees have not been previously tapped. There is always a great deal of "negro-head," the result of the distance the milk has to run, and to the large quantity of clay employed in the process.

Collection of the Milk.—Going from tree to tree at a sort of running pace, the collector empties the contents of the cups into a large calabash, which he carries in his hand. As he pours the milk out of each cup he draws his thumb or forefinger over the bottom to clean out some which otherwise would adhere. Indeed, a small quantity does remain, which is afterwards pulled off and classed as *sernamby*. The cups on being emptied are laid in a little heap at the base of each tree, to be ready for the following morning. The trees occur at various distances from 10 to 100 yards apart, and as I travelled over the intricate network of muddy footpaths, I continually felt perplexed and surprised that the natives have not yet seen the advantages that would be derived by forming plantations, whereby more than twice the quantity of caoutchouc might be collected in one-fourth the time, and at far less cost and labour.

Method of preparing the Rubber.—The collectors of the region I visited, resorted with their milk to a large shed situated on the bank of the river Guama. Here were quantities of various species of palm nuts, representing an *Attalea* and *Euterepe edulis*, stored in heaps, and several jars for the preparation of rubber. These jars were 18 inches high, and the bottoms were broken out. At the base they were 7 inches

in diameter, bulging out in the middle to 12 inches, and were narrowed at the mouth to a breadth of 2 inches. Each person wrought on his own account, and so small jars were employed, but where a number of men are collecting for one master much larger jars are in use. The milk, on being put into a large flat earthen vessel, is put down on the floor in a convenient place. Adjacent thereto the jar is set on three small stones, which raises it to 1½ inches above the floor. The narrow space between the base of the jar and the floor allows the air to enter, which causes a current of smoke to ascend with remarkable regularity and force. When the fire commences to burn strongly, several handfuls of nuts are put on, then some more wood and nuts alternately. These are dropped in at the mouth of the jar until it is filled to within four inches of the top. Due care is taken that a sufficient proportion of wood is put in with the nuts. The mould on which the rubber is prepared resembles the paddle of a canoe; in fact, at many places on the Amazon this is the article most frequently used if there is much milk, and when the rubber is prepared in bulky masses. Occasionally the mould is slung to the roof, as the weight in handling it during the process would otherwise be very fatiguing. A little soft clay is rubbed over it to prevent the rubber from adhering, and it is afterwards well warmed in the smoke. The operator holds the mould with one hand, while with the other he takes a small cup and pours two or three cups of milk over it. He turns it on edge for a few moments above the dish until the drops fall, then quickly places the flat side two inches above the jar mouth, and moves it swiftly round, as if describing the form of a cipher, with his hand, so that the current of smoke may be equally distributed. The opposite side of the mould is treated in the same way. The coating of milk on the mould on being held over the smoke immediately assumes a yellowish tinge; and, although it appears to be firm on being touched, is yet found to be soft and juicy, like newly-curdled cheese, and sweating water profusely. When layer after layer has been repeated, and the mass is of sufficient thickness, it is

laid down on a board to solidify, and in the morning is cut open along the edge on one side and the mould taken out. Biscuit rubber, when fresh, is often four or five inches thick. On being hung up to dry for a few days, it is sent to market. When I saw the process of smoking the rubber performed, as just described, I was considering the statements of Keller and other travellers who write on this subject, all of whom seem to believe that the smoke from the palm nuts possesses some peculiar or strange property by which means the milk instantly coagulates. But on one occasion, when the collector was commencing to smoke some milk, I saw him wait for a short time, during which he put his hand repeatedly to the mouth of the jar, and soon learned that he could do nothing until the smoke was hot. The dense white smoke rose abundantly, but the milk would not thicken on the mould. After a little while the jar became heated, and the operation went on quite satisfactorily. I put my hand above the mouth of the jar, but could not bear the heat scarcely a second; and, although the temperature of the smoke was apparently less than boiling water, yet I judged it must have been at least 180° Fahrenheit. Therefore the rapid coagulation of the milk is simply produced by the high temperature of the smoke. I have no doubt that, with a strong current of heated air, or a good pressure of steam from a pipe, a similar result would be obtained. The finely divided particles of soot which forms a large proportion of the smoke, undoubtedly absorbs a considerable amount of moisture, although at the same time it must be looked on as an impurity. I have no hesitation in giving my opinion that equally as good rubber could be prepared by putting the milk in shallow vessels, and evaporating the watery particles by the heat of boiling water.

Temperatures of the Para Rubber District.—I now proceed to give the temperatures taken during my stay in the region of Para. According to the natives the rains begin in November or December and end in June. However, during the intervening months of summer it will be seen that showers of rain are frequent. These usually occurred between two and three o'clock in the afternoon, and streamed down with a force

similar to the monsoon showers in India. The days on which rain fell are preceded by an asterisk.

1876.	Morning.	Noon.	Night.	1876.	Morning.	Noon.	Night.
	°	°	°		°	°	°
July *17 ...	—	88	81	September 2 ...	76	86	84
,, *18 ...	79	88	81	,, 3 ...	73	89	85
,, 19 ...	80	87	83	,, 4 ...	84	92	83
,, *20 ...	79	86	79	,, 5 ...	82	91	81
,, *21 ...	79	87	79	,, *6 ...	73	90	82
,, 22 ...	77	86	85	,, 7 ...	73	91	81
,, *23 ...	79	87	83	,, 8 ...	76	89	81
,, 24 ...	79	87	85	,, 9 ...	76	88	83
,, *25 ...	79	89	83	,, 10 ...	75	90	77
,, 26 ...	79	87	84	,, *11 ...	76	89	83
,, 27 ...	80	87	84	,, 12 ...	75	89	81
,, *28 ...	79	88	81	,, 13 ...	74	88	82
,, *29 ...	77	89	83	,, 14 ...	75	87	81
,, *30 ...	81	90	84	,, 15 ...	76	89	83
,, *31 ...	80	86	82	,, *16 ...	75	90	81
August 1 ...	79	80	79	,, 17 ...	74	88	84
,, 2 ...	77	86	83	,, *18 ...	73	87	81
,, 3 ...	78	87	85	,, 19 ...	74	87	83
,, 4 ...	79	87	83	,, 20 ...	73	89	80
,, *5 ...	79	89	83	,, 21 ...	74	88	83
,, *6 ...	79	87	84	,, 22 ...	73	89	83
,, 7 ...	77	86	83	,, 23 ...	75	91	82
,, 8 ...	80	88	84	,, 24 ...	76	90	84
,, *9 ...	80	88	83	,, 25 ...	75	87	83
,, 10 ...	79	89	84	,, 26 ...	74	92	81
,, *11 ...	78	87	82	,, 27 ...	75	92	84
,, *12 ...	80	86	80	,, 28 ...	74	93	85
,, *13 ...	79	87	82	,, 29 ...	75	92	83
,, 14 ...	77	84	81	,, 30 ...	76	92	85
,, 15 ...	77	87	82	October 1 ...	74	91	84
,, *16 ...	77	85	81	,, 2 ...	74	92	85
,, 17 ...	78	88	84	,, *3 ...	75	91	84
,, 18 ...	79	88	83	,, 4 ...	74	87	82
,, *19 ...	78	88	82	,, 5 ...	76	90	84
,, *20 ...	78	87	81	,, 6 ...	75	89	85
,, 21 ...	79	88	83	,, *7 ...	74	88	84
,, 22 ...	77	89	82	,, *8 ...	75	89	83
,, 23 ...	78	89	82	,, *9 ...	74	88	82
,, *24 ...	77	88	82	,, 10 ...	76	87	84
,, 25 ...	79	87	81	,, 11 ...	75	89	83
,, 26 ...	77	86	84	,, 12 ...	75	88	84
,, 27 ...	78	87	83	,, *13 ...	76	87	84
,, *28 ...	79	85	81	,, 14 ...	74	89	83
,, *29 ...	76	87	82	,, 15 ...	75	90	84
,, *30 ...	77	86	81	,, 16 ...	75	90	82
,, *31 ...	78	87	82	,, 17 ...	75	89	85
September *1...	76	86	83				

A glance at these figures will show that the region of the Para rubber tree has a sustained high temperature—a fact which has already been remarked by Dr. Spruce and other travellers. The lowest I could record was 73°, but Mr. Henderson assured me he had frequently seen it down to 72°, and I have the statements of another observer, on whom I coulp

rely, that on one occasion the thermometer fell to 65°. The place, however, where this observation was made was fully 100 miles to the westward of Para. In the neighbourhood rubber trees abounded.

Sites, propagation, and planting in India.—The sites most suitable for the planting of this tree will be found in the hottest parts of India. The flat, low lying, moist tracts, lands subject to inundation, shallow lagoons, water holes, and all descriptions of mud accumulations, miry swamps, and banks of sluggish streams and rivers, will be found best adapted. The tree will also grow perfectly in deep humid land, fitted for cane or coffee planting. The Malay Peninsula, Burma, the island of Ceylon, and the southern portion of India on to about as far north as 20° north latitude, should possess many localities proper.

The temperature of rain-water varied from 74° to 75° for planting ; but in no place would I recommend the formation of a plantation where the thermometer at any time falls below 60° Fahrenheit.

It seems to me that the propagation and planting may generally be combined in one operation, the object being to reduce the expense, simplify and accelerate the work, and promote the more perfect development of the primary roots and trunk. The green coloured terminal shoots of succulent growth, with the leaves fully matured, make the best cuttings. These should be cut off low enough, so that there is a joint at the base. When it is desirable to plant in dry firm land, a spadeful of soil should be turned over at each place, and the cutting planted in a sloping position. It should be covered with mould to within three inches of the point. That portion above ground should rest on the earth on one side to its termination, so as not to suffer during hot sunshine. In all stages the crowns of the plants may be exposed to the rays of the sun. Plants intended for cutting stocks may be planted in open places, in the richest dark loam capable of producing a luxuriant rank crop of sugar cane. Seeds might be planted out permanently at once, also in the same way as the cuttings. These would prosper much better if at the time of planting

a handful of wood ashes were added to the soil with each seed. Good ashes may be obtained by the burning of any description of green wood or newly felled piece of forest. If the wood is allowed to rot before burning almost the whole of the fertilizing principles will be found to have vanished. If stored in a damp place the value of the product is diminished. For planting on inundated lands the period of high flood should be preferred. Cuttings of greater length would be required in this case, the lower ends of which should be sliced off in the form of a wedge. The workman could take a bundle of these, and wading into the water would plant at proper distances, but perfectly upright, taking care to push each cutting down deep enough in the soft muddy bottom, so that not more than three or four inches is above the surface of the water. The same rule would be applicable when planting in sludge or soft marsh land. The crowns of the cuttings must not, if possible, be put under water, as the young growths springing therefrom might rot. Seeds will not be found very applicable for planting in watery places or deep mud deposits. Some would come up, but a good many would mould and decay. In the varied course of circumstances and conditions, slight changes and modifications in the methods of working will no doubt suggest themselves. I would not advocate, at least for the present, the extensive planting of this tree in fertile cane-producing lands, because in such a description of soil it would not be able to compete with the Central American rubber tree, already introduced from the State of Panama, which grows rapidly to a much greater size, and yields a far larger quantity of caoutchouc. It should rather be planted in places where nothing else could be profitably cultivated, such as frequently inundated river margins, marsh land, and mud deposits. Above 4,000 tons of Para rubber are exported annually.

Search for plants of the tree yielding the Balsam of Copaiba, Capivi of commerce.—I was recommended by Mr. Markham, just before leaving, to endeavour to obtain at Para some plants of this tree, which abounds in the forests of the Amazon valley. These balsam trees have a wide distribution, and are

likewise found dispersed in the forests of Guana and Venezuela, and in the wooded littoral districts of New Granada, especially in the States of Santa Martha, Carthagena, and Panama. In those regions different species of trees varying in size and yield, furnish balsam, but all are leguminous, and belong to the genus *copaifera*. The finest sort in commerce, called by the collectors white copaiba, is met with in the province of Para, and is shipped from Para and Maranham. Very large quantities are annually sent to the French market.

After protracted inquiry I discovered that few people really knew the tree, and I was beginning to think that I might not be able to obtain any knowledge of it, when fortunately I learned where a practical copaiba collector lived. Formerly the tree might be seen growing in places easy of access, but owing to the method of collection practised it is now comparatively rare. At present a collector must make a journey, occupying several weeks, in a canoe up some of the Amazon tributaries, or penetrate into the dense forest lying between the rivers, to find any considerable quantity of copaiba.

It cost me three successive journeys on foot, occupying three days, before I could arrange with the collector. He was drinking a supply of cane rum (*cachass*), and he would not go anywhere until it was finished. Few occupations are so perilous and fatiguing as that of the balsam collector. Exposed daily to the drenching rains in the depths of the forest, with often an insufficiency of food, bitten by large formidable ants, and tormented unceasingly by day and night by swarms of mosquitoes, his life is of a wretched description. When living under these conditions the smallest scratch from the underwood is apt to become a sore, and increase to the size of a florin in forty-eight hours. On the 17th of September I left with the lad, and joined the collector at the entrance to the forest. The path led through a dense lofty vegetation, the majority of the trees being from 80 to 100 feet in height. The extremely fertile soil was of soft white sand, 20 feet or more in depth, covered by a thick surface layer of vegetable mould with which the sand was intermixed. Slight undulations were traversed, and three little running streams were

crossed, none of which contained more than a mill of water. The land was everywhere quite mealy and dry, and was elevated at least 50 feet above the region of the *gapós* or tidal floods. Large black ants, some of which were nearly two inches in length, called by the natives *candela*, ran over the ground everywhere. The bite of this ant is quite as painful as the sting of a wasp in this country. After travelling several miles we came to a balsam tree of gigantic dimensions. The saplings had been cut down around it by a person who lived some distance away, and who consequently was considered the owner. The tree appeared to be 80 feet in height, with a clear trunk of 50 feet. On account of the great thickness of the trunk, and absence of branches, no one was able to climb it. The clearing away of the underwood admitting freely air and light had induced the tree to bear seed, which, however, was just beginning to ripen. Little perpendicular rents were observed in the bark of the trunk from eight inches to a foot in length. From some of these, which had occurred quite recently, a little balsam had exuded, and flowed down the trunk. A diligent search for plants was made, and one small seedling was found by the collector, which I rejected, as I doubted whether it was really a balsam plant. Without much loss of time we continued our journey along a narrow path lined with tall grass and shrubs. At mid-day we came to some copaiba trees, one of which had been tapped some years ago. It had a massive lofty trunk, and wide spreading crown, and must have borne many crops of seeds, but not one plant was to be met with. A further search beneath a number of other trees which were scattered about proved alike fruitless. The collector explained that the seeds on falling were immediately eaten up by an animal about the size of a rat. This fact fully accounted for the scarcity of seedlings. Everywhere underneath the trees a close network of little paths traversed the ground. We penetrated this day into the forest for a distance of 12 or 14 miles, and got neither plants nor seeds. I had a little fever afterwards for about a day, which, although mild, weakened me considerably. I felt that the daily exposure in the sun afterwards fed the symptoms which remained.

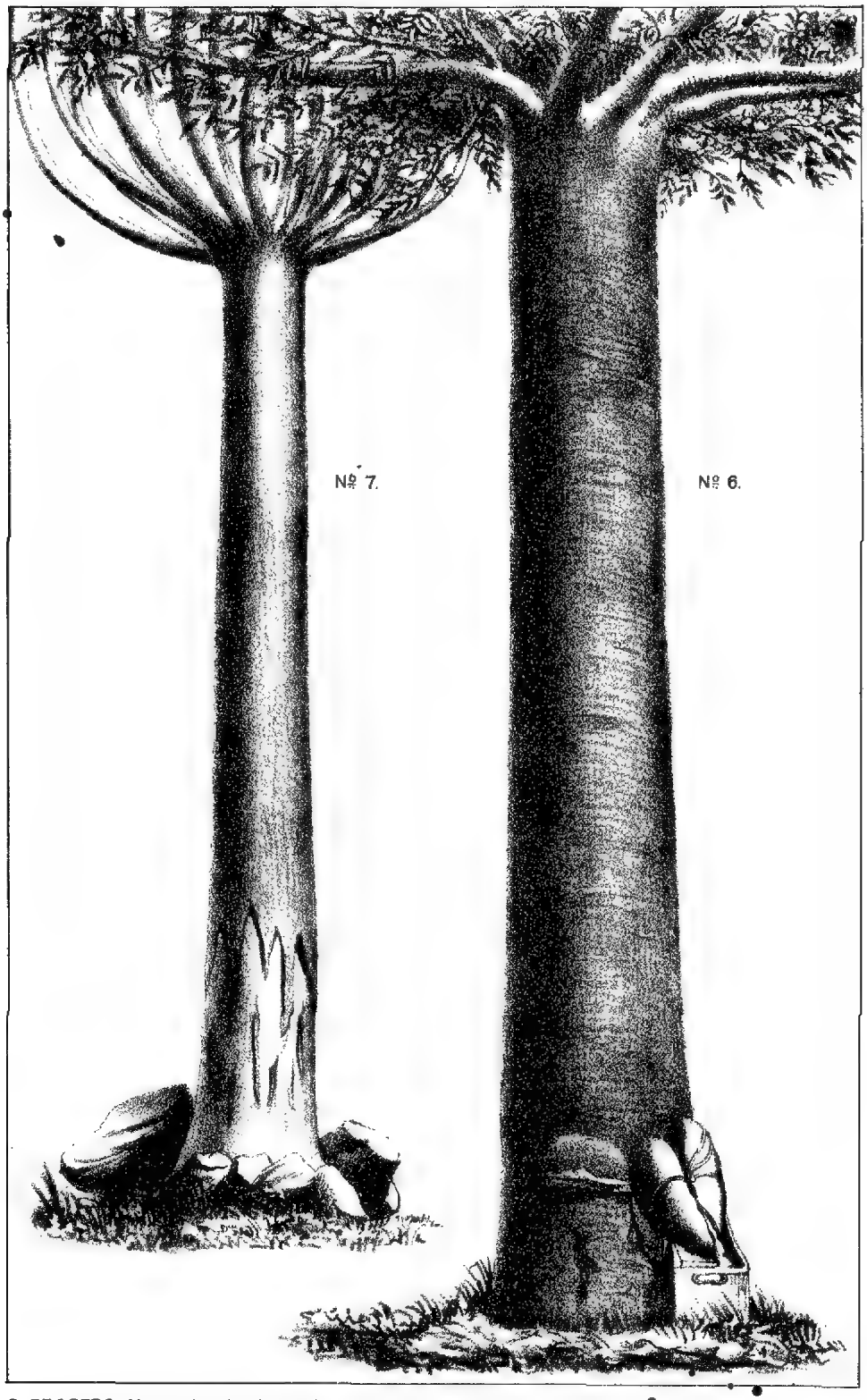
On the 9th of October I took with me the lad, and returned *to examine the copaiba tree in fruit* already noticed. A number of capsules were found beneath it, but all were empty. The ground was thickly covered with the little paths of the animal which had devoured the seeds. Whilst engaged in searching about a gentle breeze of wind arose, which, moving the branches, brought down a few seeds in the best possible condition. These were carefully gathered, and in all 18 seeds were collected. Each little pod contains only one seed, which is coated over with a white wax-like substance, possessing a delicious aroma. When this is removed the seed is found to be black, and about the size and form of a field bean. The time was at hand when I purposed to leave with the rubber plants, so as to get to England before the cold weather set in, but I resolved, if possible, to see the method of tapping the trees actually performed. *This operation has not yet been* accurately described by any traveller, and no scientific work or class book in the English language gives a correct account of the process, for which reason I take the liberty of recording my observations.

Early in the morning of the 13th October I proceeded to the forest, accompanied by the lad and the copaiba collector. To each was assigned a fair travelling load, consisting of food or other necessities, but the most prominent object was a large tin capable of holding about 40 English pints, which the collector carried on his back. We travelled by a path to a point beyond the place reached on a former occasion, and then diverged into the forest, where there was no track of any kind. Entering on a district where the trees were an amazing height, we in a short time came to a very large copaiba tree. This, and a number of others, were previously known to the collector, who tapped one or two when convenient. I found he did not want the lad to see the largest of these trees, lest he might show them to others. On reaching the tree, he struck the trunk two or three blows with the handle of his axe, when a sort of hollow sound was produced. The grand symmetrical trunk was clear of branches to a height of at least 90 feet, above which the crown spread out flatly, the slender interlaced boughs, clothed

with little pinnate foliage, forming an agreeable shade from the rays of the sun. The circumference at 3 feet from the ground was 7 feet 2 inches. Several old fissures in the bark were observable, and one, which had occurred quite recently, was nearly 5 feet in length. Very little balsam had exuded. These rents are reported to be occasioned by the accumulation of oil in the tree, and that when they happen a loud report is heard.

The person who successfully taps a copaiba tree must be a skilful axeman. A chamber or cavity is cut in the trunk, not much broader than the axe, but sufficient to allow the workman to vary the course to the heart of the tree in such a way that he may not miss what is termed the "vein" or channel, usually met with near the centre, from which the balsam flows. The base or floor of the chamber must be carefully and neatly cut with a gentle upward slope, and it should also decline to one side, so that the balsam on issuing may run in a body until it reaches the outer edge. Below the chamber a pointed piece of bark is cut and raised, which, enveloped with a leaf, serves as a spout for conveying the balsam from the tree to the tin.

The collector commenced the work by hewing out with his axe a hole or chamber in the trunk about a foot square, at a height of two feet from the ground. The wood at first was white to a depth of four or five inches, when it changed to a purplish red, very much resembling a piece of old oak taken from a peat moss or bog. The whole of the interior of the tree is of this colour. When the centre appeared to be reached, I was about to remark that there was no balsam, when suddenly the collector laid down his axe and called hastily for the tin. The balsam now came flowing in a moderate sized cool current, full of hundreds of little white bubbles possessing a pearly transparency. At times the flow stopped for several minutes, when a singular gurgling noise was heard, after which followed a rush of balsam. When coming most abundantly a pint jug would have been filled in the space of one minute. Owing to the diminished light consequent on the thick masses of foliage overhead, I could not distinguish



6. PROCESS OF TAPPING THE TREE YIELDING BALSAM OF COPAIBA.

7. CEARÁ INDIA RUBBER. REPRESENTING THE SURFACE BARK OF THE LOWER PORTION OF THE TRUNK PARED OFF AS PRACTISED BY THE COLLECTORS IN BLEEDING THE TREE.

the "vein" in the heart of the tree, but I observed a number of fissures that appeared to radiate from the centre outwards. Whilst making these observations I was surprised to see that the whole of the wood cut through by the axeman was bedewed with drops of balsam, and so also were the ends of the chips. This remarkable and important fact shows that every atom of wood in the tree contains a certain amount of copaiba. The bark did not appear to possess a particle. In the course of an hour nearly one-fourth of the tin was filled. A little roof, thatched with leaves, was placed over it as rain began to fall heavily. We then returned home. The collector considered the tin would be filled, and proposed to return for it in a couple of days. Although balsam may be seen slowly dropping from a tapped trunk for a month after it has been operated on, the common practice is to allow a tree, if it be good, only two or three hours to drain, and then to proceed to another. Occasionally large trees are met with which when tapped yield little balsam. The cause of this has not been ascertained. Trees of the largest size in good condition will sometimes yield four "potos," equal to 84 English imperial pints. A collector, where trees are abundant, and with plenty of vessels, can, it is said, make at the rate of 5*l.* per day. Mr. Clough, an English missionary, in describing in a recent work* the method of collecting balsam, says that it "is obtained by making a gash in the bark of the tree, and plugging the space with cotton, to absorb the juice which exudes." I will venture to state that not a drop would be obtained by this process. Nor is the practice, as stated by some, of closing the cavity cut in the tree for a time with clay or wax, to allow the balsam to accumulate, ever resorted to. Even if tried it would not answer, for a number of reasons. Balsam, as it comes from the tree, has a powerful pungent fragrance, which is not particularly disagreeable, although on passing the doors of the houses where it is stored at Para an odour, by no means pleasant, is experienced. Possibly some change may take place in keeping. Little, if any, care seems to be taken

* "The Amazon: A Twelvemonth's Tour," by S. Clough.

to preserve the commodity pure. Those who go up the rivers to collect on a large scale take in their boats all descriptions of jars and barrels which may have been imported with liquors, grease, or any kind of article. Paraffin cans are special favourites, and so are much sought for. Most of those vessels, on being emptied, are stowed away in dusty places, uncorked and uncovered, thus affording free ingress to ants, spiders, and all classes of insects. It is urged by some that balsam precipitates all impurities, but even if this were so, a better system might be adopted. As some of the seeds brought home have germinated at Kew, I may add a few remarks regarding the cultivation in India, whether a few plants should be sent when strong enough for removal. I trust care may be taken at Kew to keep this sort separate from other species cultivated there, mostly natives of the West Indies, and which, although interesting in what may be termed a "botanical sense," are of no value for the production of copaiba. The temperature required is the same as that for the Para rubber tree, which at times is found growing beside it. Wet or marsh land must be avoided. The site should be of the best dry loam, suitable for cane or coffee planting. The stock for planting will have to be obtained from seeds ripened in India, so that, if a few plants can be transferred thither, they should be planted in good situations, where plenty of sunshine is admitted, in order that seed may be early produced. Seedlings may be planted tolerably thick, so as to shoot rapidly up, when they can be thinned out to proper distances.

I would not recommend the planting of these trees on a large scale with a view to early profit, as the growth would be slower than Panama or Para rubber trees. The return would, I think, be realized in about the same time as is the case with oak plantations. However, a few hundreds of copaiba trees growing on a planter's estate ought to enhance the value of it. Apart from the medicinal value of copaiba, it might be well to ascertain if it would not be equal to castor oil for lubricating machinery. The journeys relating to this work were among the most fatiguing I have experienced in these countries.

Examination and collection of seeds and plants of Ceara

India-rubber.—On the morning of the 26th I went on shore at Ceara, as I wished to gain some knowledge of the method adopted in the preparation and collection of the rubber exported from Ceara. I had to land from the ship in a *jangada*, which is a raft 12 or 14 feet in length, formed of moderately-sized trunks of a tree fastened together, and furnished with a mast and large sail. A piece of board, a foot in breadth and four feet long, is pushed down in the middle between two logs, to serve as a keel. The tree selected for those rafts has a peculiarly light wood said to be brought from Bahia or Pernambuco. With a good fair wind they are said to run sometimes at the rate of 15 knots an hour. The surf is so strong that no boat or canoe could often reach the shore safely. Even the *jangadas* are sometimes overturned, and when this happens there is a risk in getting a blow from the timbers of the raft—a danger considered greater than the sea. In the town I saw a large quantity of rubber in a merchant's store, and afterwards observed that it was freely traded in by most classes of shop-keepers. I expected to have seen the tree yielding it somewhere near, but after travelling about over the sand-hills and adjoining country for the greater part of the day, I returned to the ship completely tired. I was assured by a native, who said he knew the Para rubber tree and that of Ceara, that both were completely identical. But the great diversity in the climate induced me to think different, and so I resolved to follow out the dictates of my own judgment, and not be influenced by any one until I could satisfy myself on the matter. Yet there was little time to explore, as the steamer was expected to leave in a very few days. Next morning an Indian from the interior happened to come on board the ship, and I took the opportunity of asking him the names of some of the villages and localities in the retired districts. I knew from previous travelling a good number of the Indian substantives, with their meanings, and this, together with further conversation, enabled me to form some idea of the character of the region where the rubber was collected. A single line of rail, formed to facilitate the transport of sugar and cotton, runs from Ceara into the interior to a place called

Pacatuba, distant about 40 miles. Contiguous are a number of large plantations with some slaves. On Sunday, October 29th, I landed with the *jangada*, and proceeded through the town to the railway station. I had previously arranged with a native to accompany me, but he did not appear, so I went off alone. Leaving Ceara, a flat parched-up region was traversed, diversified by a few undulations and moist hollows. Thorny thickets of bushes and slender trees, chiefly myrtles and legumes, overspread the country, with many groups of the Carnaúba palm, *(Copernicia cerifera)* rising high above the ordinary vegetation. The crowns of these palm trees waved about by the wind and visible over such a wide expanse presented an appearance extremely picturesque, whilst in the distance beyond rose a multitude of conical peaks and mountains, the whole combining to form a landscape of surpassing beauty. After a journey of two hours I stopped at a little village with about a dozen thatched houses, called Maracanahu. The distance may be 30 miles from Ceara. I went to a man and boy who were standing in front of a hut, and made some proposals to them to show me the locality where the rubber trees grew. The man was advising the boy to accompany me, who seemed rather reluctant, when a poor lad, who had lost an arm, came up and at once consented to go with me. It was fortunate I met with this one-armed lad, as I could hardly have succeeded so well with any one else. I told him I wanted first to see trees that were being wrought, because I wished to make sure of the tree, and also observe the method of collection. We proceeded along a dusty path for some distance, at times running, as I proposed, if possible, to return with the train which passed the village in the evening. Plantation establishments were seen dispersed at wide intervals over the country. Cultivation was only carried on in very low moist situations, or where the water during the rains was stored up in artificial ponds for irrigation. Some of these were so large that at first I took them to be natural lakes. After travelling for some time the lad turned from the path and dived into the forest. In a few minutes he brought me among a number of rubber trees which had recently been bled. The general forest was toler-

ably high, but the sparse small foliage did not afford much shade from the fierce rays of the sun. The soil was in places a sort of soft sandstone or gravel, which was bound up in the most extraordinary manner. Neither grass nor weeds grew among the underwood, and there was an entire absence of ferns, mosses, and other plants. I soon saw that the tree was totally different from the rubber tree of Para; and also that it would probably thrive perfectly over a very wide extent of the drier regions of India. At first sight it much resembles in appearance a birch tree, and the surface or epidermis of the bark comes off in the same way in thin silvery peelings. The largest of the trees were about 50 feet in height, with trunks nine inches to a foot in diameter. The crown is divided into many branches, which grow in the form of a basket. The tree is deciduous, and there were neither leaves, flowers, nor fruit to be seen. I spent some time in examining attentively the process of bleeding the trees, and then commenced to search for plants. A few were found growing in an open space, but the roots were so firm that not one could be pulled up. It seemed strange that the lad and myself, exerting all our strength, could not pull up a young seedling plant about two feet high. I went and got a pointed branch of a hard wood tree,* and scraped and dug about the roots, and in this way, with very arduous work, during which I hurt and lacerated my hands, some plants were got up. The real difficulty was now apparent. The roots of the plants were furnished with tubers, the largest of which were about the size of kidney potatoes. These tubers, although quite near the surface, adhered with such tenacity to the sandstone, or hard gravel, that most of them had to be smashed in order to get away an uninjured portion of root with the stem. In the young state they are soft and spongy, and are seen to contain milk, but afterwards become lengthened out, and form a part of the root. With diligent search and hard labour we succeeded in collecting 18 plants. At the station, a number of natives from Ceara gathered round the "bundle of sticks," but could not make out

* It seems strange that Mr. Cross should have gone out without tools.—Ed.

what they were. However, an old man from the forest district came up, and, peering through the crowd said, "Manisoba." This is the Indian name of the rubber tree, which I knew before. I got back to Ceara just before dark, and fortunately found a *jangada*, which put me on board. Thus in one day I was fortunately able to discover the origin of a tree, hitherto unknown and undescribed, yielding an important article of commerce, and at the same time resolved the mode of collection and preparation, and secured a number of plants. It is true I had no instructions regarding this Ceara rubber plant, probably because it was supposed to be the same as the Para tree. But I thought it would be well to secure more plants, and told the owner of the *jangada* to come for me in the morning. This sort of raft was expensive; each voyage cost me three *milreis* (6*s*.), and I could not possibly have got one for less. The distance was only about three hundred yards. Next day the sea was very rough, and three *jangadas*, one of which carried the Brazilian Government mails, were overturned in the surf. The person I arranged with came for me, and I embarked. Although I was not in the least alarmed, the size and violence of the waves completely surprised me, while the *jangada* at full speed went groaning through the surf, covered by nine inches or a foot of water. I cannot help wondering that not a farthing has been spent in improving the safety of these Brazilian ports.

Returning to Maracanahu, I proceeded to an adjacent house, where I was previously told I could stay. The son of the owner assisted me in obtaining a quantity of seeds, 700 in all. The pods when ripe burst and go to pieces, and so the seeds are showered on the ground. At daybreak next day we went in search of plants. We brought a strong iron hoe, as my intentions were to take up a good number, for I did not place much confidence in the seeds, although I am glad to state they have turned out well. Our course was directed to a more distant part than I had previously visited. Shortly after entering the bush-like forest we came on a large tract of land covered by immense masses of grey granite, some of which might be 50 tons or more in weight. These had been broken

where they lay, and were the result of a volcanic explosion. Rounded masses of the same rock also cropped out in many places. Travelling now became very difficult, as we had occasionally to scramble from one block to another on our hands and knees. Many good-sized rubber trees were growing in the spaces between those granite masses, but no plants were seen. The situation was very dry, but no doubt some seedlings had sprung up, which, owing to numerous thickets of shrubs, were not perceived. After fully an hour of tiresome exploring I resolved to go back to the place where I got plants previously. We there succeeded in collecting a number, which, with those formerly gathered, amounted in all to 60. The handle of the hoe broke, for which reason the work was not further prosecuted. Taking with me the seeds and plants, I returned to the steamer in the afternoon.

System practised in bleeding or tapping the trees, and collecting the Rubber.—This is an operation of a very simple description. On commencing to work the collector takes with him a stout knife, and a handful of twigs to serve as a broom. Arriving at a tree, any loose stones or dust are swept from the ground around the base, and some large leaves are laid down to receive the droppings of milk which trickle down. Some do not go to the trouble of sweeping the ground or laying down leaves, for which reason the milk adheres to sand, dust, decayed leaves, and other impurities. The outer surface of the bark of the trunk is pared or sliced off to a height of four or five feet. The milk then exudes, and runs down in many tortuous courses, some of it ultimately falling on the ground. After several days the juice becomes dry and solid, and is then pulled off in strings and rolled up in balls, or put into bags in loose masses. Only a thin paring should be taken off, just deep enough to reach the milk vessels; but this is not always attended to. Nearly every tree has been cut through the bark, and a slice taken off the wood. Decay then proceeds rapidly, and many of the trunks are hollow. In this condition the trees must yield far less milk, and many, no doubt, are broken over by the wind or wither away. Collecting is carried on during the dry season only when rain seldom falls.

Climate and Temperature.—The flat country from Ceara, running back to the mountains, in which the tree abounds manifestly possesses a very dry arid climate for a considerable part of the year. This is evident from the fact that mandioca and other crops require to be irrigated. The rainy season is said to begin in November and end in May or June. Torrents of rain are then reported to fall for several days in succession, after which the weather moderates for a brief space. According to some statements, there are occasional years in which hardly any rain falls. This assertion concurs with the aspect presented by the country in general. The daily temperature on board the ship ranged from 82° to 85° Fahrenheit, but inland it is often probably 90°.

The localities traversed by me nowhere seemed to be elevated more than 200 feet above the sea. The situations selected for cultivation in India should possess a rather dry and sustained high temperature. In the comparatively low-lying coast country of the southern portion of the peninsula of India, including the districts of Madras, Cochin, Calicut, Cannanore, Mangalore and Bombay will be found many localities possessing all the conditions essential for the growth of Ceara rubber. The plant might likewise be tried in the deep tropical valleys of Assam, and, indeed, in all the parched regions of India within the limits of coffee planting. It may not be safe, at least until some experience is gained, to plant in any locality where the temperature at any time of the year falls below 50° Fahrenheit.

Propagation and Planting.—Seeds are early produced if the tree is not shaded. They should be buried in brown sand, kept pretty moist until there are indications of growth, when they may be planted out permanently. In some situations where the ground is rough and strong they might be sown broadcast. Meantime I would suggest the formation of plantations by cuttings, which will take root as easily as a willow. These should be taken from the points of strong shoots, and may be one foot in length. In planting, each cutting may be put down in the soil to a depth of six inches. If scarce, the entire shoot may be cut into pieces, each possessing a bud, all

of which will grow if covered with half an inch or so of soil. On loose sandy soils or exhausted coffee land, plantations may be formed at little expense. Dry, hard, gravelly wastes, if found to support any kind of bush, are also suitable sites. Holes might be made in strong land with an iron jumper, and a stout cutting put into each and filled with pebbles. On bare or thinly-covered portions of rock the cuttings might be laid down flat, and a little heap of stones or any kind of *débris* about the size of a molehill, piled over each, care being taken that the extreme point of each cutting with a bud is left uncovered. I do not advocate planting in an entirely barren desert, but wherever there is any sort of stunted tree or scrub vegetation, with an occasional sprinkling from a monsoon shower, the tree is likely to prosper. Ceara rubber occupies a position in the market. The export has been stated to amount to 1,000 tons per annum.

Arrival in England.—The steamer left Ceara on 2nd October, and arrived at Liverpool on the 22nd of November. The plants were deposited at Kew early on the morning of the 23rd. There were fully 1,000 plants of Para rubber, *Hevea Braziliensis,* in the best condition. Exclusive were the Ceara plants, all of which arrived sound and have done well.

I have looked at the collections of dried plants in the State Herbarium at Kew, but no specimen could be found of the Ceara rubber tree. Judging from pieces of the capsules and the seeds, it would seem to belong to the same family as the Para sort. From the fact that it has tubers attached to the roots, Professor Oliver, the Curator of the Herbarium, suggested its similarity to the mandiocca (*Manihot*), and this in some respects is really the case. The tubers are probably poisonous, which, however, is a prominent feature of the *Euphorbiaceæ*, but in the form, markings, texture, and liability to rot when cut or bruised, they strikingly resemble some varieties of mandiocca.

Observations relating to the Rubber-producing Tree of Central America.—I will now add a few remarks concerning this tree, which I collected in the interior of the Isthmus of Panama towards the latter end of 1875. This, because I think it has

not received the attention it deserves. There are now a good collection of plants at Kew, and I am surprised that more have not been sent to India.

The tree inhabits wooded regions near Guayaquil and Buenaventura, and has likewise been met with abundantly in the State of Panama, and in the Republics of Costa Rica, Nicaragua, Honduras, Guatemala, and Mexico. It is one of the largest and most massive of the trees of western tropical America. The trunk often attains to a surprising thickness and height, yielding in some instances above a hundred pounds of India-rubber. The wood is extremely soft, and when cut into decays rapidly. The destructive method of cutting down the tree to be tapped has exhausted extensive rubber localities; and, although others may be opened up, yet the supply is certain to diminish at no distant date. Even where the trees are not felled, as in Nicaragua, the method of tapping, by which the wood is injured, is so unskilful that it has been considered by some as preferable to cut the tree down at once. The climate of various of those rubber districts is hostile and severe, and some places, such as the forest regions of Buenaventura and Choco, have no parallel in the universe. Throughout the State of Panama drenching rains are almost of daily occurrence, and occasionally on the Atlantic side hurricane blasts make avenues in the forest.

The district investigated by me, and where the plants were collected, was reached by ascending for some distance the River Chagres, and then travelling for several miles through a stately forest into the heart of the isthmus. The trees seen exceeded in height and dimensions those met with in the wooded districts of the Amazon. An undergrowth of a thorny wild pine apple (*Bromelia*), 10 feet in height, everywhere formed extensive thickets. Large powerful snakes were numerous, and so audacious that they deliberately rose up to strike at any one that approached. The young rubber saplings were found growing most abundantly on the banks of cool, clear running streams and little dribbling rivulets. The roots could easily be traced over the surface of the ground running down to the very margin of the water. But the tree grew also on emi-

nences, steep declivities, and varied elevations, and in such abundance that the first explorers gave the name "Caoutchouc Hill" to a height which they found crowned with a forest almost entirely composed of rubber trees. It was not seen growing anywhere on swamp or marsh land. Although the rubber districts are proverbially rainy, yet the tree was seen by me growing beside a stream on the border of a desert tract of country bounding the Gulf of Guayaquil, where only a few light showers of rain fell during the year. On both sides of the stream there was a strip of good forest, but beyond thickets of cacteæ and low spreading legumes formed the characteristic vegetation. I mention this fact to show that the tree will probably succeed well in regularly-irrigated districts, even if the atmosphere be dry and dusty. The temperature in the woods of the isthmus ranged from 75° to 88° Fahrenheit. Rain water, examined the moment it fell, was never found to be below 74°. The usual practice in collecting the milk was by felling the tree, and then making deep notches around the trunk at distances not exceeding one foot apart. Broad leaves were placed beneath these to receive the milk, which afterwards was collected in a large calabash or other vessel. A hole was then dug in the ground, and the milk poured into it and thatched over with leaves. It coagulated in about two weeks. Another method was to bruise a handful of the large broad heart-shaped leaves of a climber, a species of *ipomea*, and stir these about in the milk. By this operation the milk thickened in less than an hour, having the appearance of a jelly-like mass, but very porous, and exuding profusely a black ink-like water whenever touched or moved. This system of preparation produces an inferior article, and I have seen some buyers from the United States cut up the large juicy flakes into slices, an inch or so in thickness, and dry them in the sun. The temperature of the sea-water along the west coast, where the rubber tree grows, is high, and does not vary much during the year. In the Gulf of Guayaquil it is usually 78°, at Buenaventura 80°, and in the Bay of Panama 79°. The water of the River Chagres, although 80° in fine weather, falls during violent rains to 76°. On such occasions many fish are to be

seen in certain places floating about in the water benumbed-like or dying. I do not know if this is the result of the sudden lowering of the temperature, or if it is to be attributed to the great quantity of decayed vegetable matter brought down by the discoloured swollen torrents from the interior of the forests.

In India there are many districts which possess all the climatic conditions necessary for the successful cultivation of Central American rubber. From Bombay southward the majority of the deep debouches of the ghauts coming from the base of the western slope of the Malabar hills, including the humid forest region extending in places down towards the coast, contain many excellent sites. In Ceylon and Southern Burma and the Malay Peninsula, the tree is likely to thrive in all proper situations. Calicut is about in the same latitude as the centre of the region occupied by this rubber tree in its wild state. The deep recesses of the Sispara Ghaut really closely resemble some of the caoutchouc districts adjoining the River Dagua. The sites selected ought to be at low elevations, and no place should be tried where the temperature at any time during the year falls below 60° Fahrenheit. Marsh land must be avoided. In dry desert localities the tree may be expected to do well when planted along the banks of canals, or any description of channels where water is flowing for the whole or a portion of the day. Trees in good situations will produce seeds early, but these will require to be planted without delay, as drying destroys their vitality. But cuttings must be resorted to first, and stout branches, cut into pieces each possessing a bud, and covered lightly with soil, will generally be found to grow. Strong cuttings, a foot in length and furnished with buds, when planted in the usual way, will become strong plants sooner. However, the propagation of this tree will not be found so easy as the Ceara rubber.

In the planting out of young plants, the petiole or leaf stalk of the lowest or oldest leaf should be buried in the soil. By following this simple rule the plant commences to grow at once, its growth is vigorous and the trunk symmetrical.

But if at the period of planting there is much bare stem above ground, then growth is usually slow, the plant remains "leggy" for some time afterwards, and never makes a good tree. If the plants get a little attention until they are four or five feet in height, I do not think there is any description of weeds or forest growth in India that will afterwards overtop them. The rapid growth of this tree, by which a large amount of vegetable mould is added to the soil, is an important feature. My own opinion is, that if planted in suitable places and properly wrought, it will be found to yield a larger return per acre than any other plant or tree cultivated in India.

Concluding remarks.—In commencing the cultivation of these trees in India, it may be well to ascertain by actual experiment, as early as possible, the species likely to yield the largest amount of caoutchouc. It is possible that as regards quality there may be little, if any, difference in the milk of the various kinds when collected and prepared in the same way.

As has been already stated, each of the three sorts require rather different sites, a wet or swamp situation being most natural to the Para tree, while the moist banks of rippling streams or rivulets will be found well suited for the species from Panama. The Ceara tree is not delicate, and will grow and produce rubber in situations where oth er kinds if planted would be dried up. For these reasons, it is likely to prove a valuable plant in India in parched-up regions and stony unproductive lands thinly covered with soil. The cup method, if employed in an extended way, may be found a convenient mode of tapping. Thus 20 rows of cups distributed over the entire trunk might be put on at one time. The earth could also be cleared away from underneath the large roots to allow of their being properly tapped. Even by the rude method adopted in South America, by which the wood is much hacked, the roots are found to yield milk abun dantly at all seasons of excellent quality. But whatever method is adopted, it is evident that if care is exercised tapping may be carried on continually. The Para tree in many localities gets no rest, except during a very "wet moon," or when the collectors are

drinking *cachass*. Therefore, the idea of giving the trees one or two years' rest ought not to be entertained. The Ceara method of paring off the surface of the bark might be tried on any of the sorts in dry weather. Para and Panama trees may be tapped on attaining a diameter of say 6 or 8 inches, and that of Ceara with a diameter of 4 to 5 inches. A collector in a plantation working with cups should be able to collect easily from 8 to 10 pounds of rubber per day. On the Amazon, in newly-opened districts, where the trees have not been operated on before, practised hands are sometimes able to collect from 20 to 30 pounds daily. A much greater quantity may be collected in even a shorter time on the Isthmus of Panama and adjacent regions, but then the trees are cut down to obtain the milk—a plan which it is assumed will not be followed in India. The cup process of tapping, the most general in use in the Amazon valley, is an Indian method, and is said to have been in use amongst them at the time America was discovered.

No time should be lost in reducing the milk, when collected, to a solid state, for if this matter is delayed, decomposition takes place, which furnishes much of the impurity complained of by manufacturers. If possible, the milk should be coagulated on the day it is collected. The milk of some species, such as that of the Panama rubber tree, may keep for a week or more in a cool shady place, but Para rubber milk spoils within the space of twenty hours, and gives off a most disagreeable odour. All the Para rubber is prepared by the smoking method I have described. Where nuts cannot be easily found green foliage is used instead. The "fumes of sulphur," "ammonia," or "acetic acid" are never employed. Alum is generally used in thickening the "mangaba" milk in the south of Brazil, but it appears to destroy the elasticity of the rubber. The watery portion may be evaporated by placing the milk, in small quantities at a time, in shallow vessels attached to any simple form of hot-water apparatus. Either this or the adoption of a smoking method similar to that of Para will probably be found the best. The material should be prepared in thin flakes about 1½ inches in thickness.

Those pieces, if made square in the form of a bale, could be fastened together and covered with coarse cloth. In this way rubber would be both easily handled and stowed.

The milk of *Masseranduba* (*Lucuma procera*), and of one or two milk-yielding trees of the Amazon districts reported to be mixed frequently with Para rubber, possesses no elasticity when prepared separately.

The island of Borneo has been suggested to me as a place specially suited for the formation of India-rubber plantations. No doubt they would grow there as well as in India, but probably not any better. Although the position in point of latitude may appear in favour of Borneo as regards the Para tree, I doubt if the climatic conditions of that island excel in any particular the southern portion of the Madras Presidency at low elevations. It must be remembered that what is termed by some the "equator of heat" is considerably to the north of our geographical equator. On the American continent it may, I think, be placed at not less than ten degrees of north latitude. In the dense forest regions of the Amazon and Panama Isthmus, the most striking feature is the extraordinary development of certain trees, occupying large spaces of ground, chiefly *ficus* and *bombax*, mantled by a dense profusion of leafy climbers, the trunks and branches clothed with parasitical plants. In India, as for instance, in the best forest portions of the Sispara Ghaut, there are no conspicuous large trees with buttressed roots, but there is a far more even development of general forest trees, and I have no doubt if an acre of such land was cleared, and the wood thereof weighed, it would be found to equal, if not exceed, the product of a similar extent of ground in the wooded districts of tropical America. Apart, however, there remains a more positive proof of the capabilities possessed by the climate of Southern India. The cocoanut and mango trees can only be cultivated in the hottest regions of the tropics. Now I have visited places where these trees were planted by the natives, such as Jamaica, Hayti, St. Domingo, Porto Rico, Santa Martha, Carthagena, Panama,

Buenaventura, Jumaco, Bahia, Esmeraldas, Guayaquil, and Para, but nowhere was the fruit superior, nor hardly so large as the mangoes or the cocoanuts of the Malabar coast. For these and other reasons I have confidence that there exist the necessary conditions for the successful cultivation of the American rubber yielding trees in many parts of India.

In conclusion, I trust the way in which I have performed these services may be considered satisfactory.

I am, SIR,

Your most obedient Servant,

ROBERT CROSS.

Ficus elastica in Arakan.

No. 19.

To the Commissioner of Arakan.

Dated Arakan Hill Tracts, May 23rd, 1878.

Sir,—Referring to your Docket marginally noted, received only on the 15th instant, I have the honor to report, for the information of Government, that the rubber which has this dry season been brought down for the first time to our Northern Frontier by Clans of the little known "Shandoo" or "Poor" race is alleged by them to be received in barter from the "Looshais;" but as these Shandoo Clans are of the wildest and most suspicious character, it has been undesirable to press them too closely on the point of the locality from which they obtain the same, as several had never before seen a European, neither visited us.

No. $\frac{431}{431}$ of the 24th ultimo.

2. If too much eagerness is evinced on the subject, on first introduction to our new guests, they will leave with the impression that, if we learn the source of the product, Government may occupy their country, and hence the information, meagre as it is, elicited from them on the point, in course of casual conversation (for direct queries are out of the question), has to be received "quantum valeat."

3. The Tribes who have recently brought down the trade mostly reside to the south and north of the "Blue Mountain,"* and some in territory, a large portion of which is unsurveyed and undefined.

For position, *vide* O'Donel's map, published by Government of Akyab District.

4. My own impression is that the *Ficus elastica* is indigenous to the above tract of country, and that the theory of their obtaining the same from the Looshais is a blind, because—

1*st.*—The natural outlet of the rubber trade from the Looshai country is "Demigiri," in the Chittagong Hill Tracts;

2*nd.*—The relationship of the above referred to "Shandoo" tribes with the "Looshais" is the reverse generally of that intimate and friendly kind which would allow of their obtaining it, when the Looshais have had for some years a good mart for it in the Chittagong Hill Tracts.

3*rd.*—Indirect information supplied me points to the fact that the *Ficus elastica* is to a limited extent indigenous to the tract of country about half a degree south of the Blue Mountain.

5. *I trust next season to have time to learn more of*, and improve our relationship with, these independent tribes, who mostly bring this article down, and heretofore only known to the Government as inveterate marauders on British Territory. I shall then be in a position to afford more definite information on the subject. Doubtless if the Arakan Hills is the *natural outlet*, and not the adjoining frontier of Chittagong, as also if our border remains *quiet*, a trade in this new industry will be established. It may be observed here, as pertinent to the question, that when on duty at Chittagong in September last I ascertained that for the last two years there had been a marked decrease in the amount of rubber exported from the Hill Tracts. An explanation on this point is deserving of attention.

From Deputy Commissioner, Chittagong Hill Tracts.

I have, &c.,
W. G. HUGHES, *Captain*,
Supdt. of A. Hill Tracts.

* The "Blue Mountain" is in latitude 22° 30," N.